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VOLUME 3, No. 9 SEPTEMBER 1951

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WORLD CROPS

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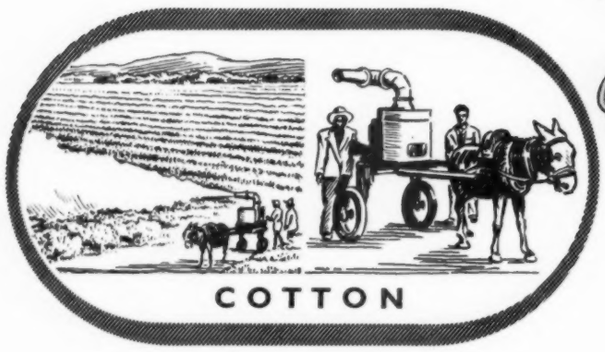

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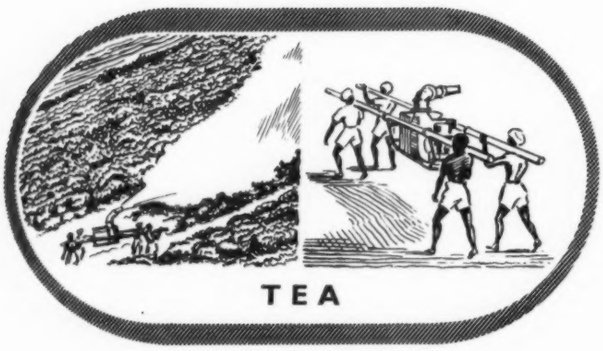

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UNICROP AGRICULTURAL CHEMICALS

Editorial Comment

Our second birthday

THIS number marks the second anniversary of the publication of WORLD CROPS. To our contributors and to the rapidly increasing number of subscribers we tender our thanks for their continued support.

Population pressure

AMONG the world's most pressing problems is the excessive population increase in the Far East. Take India as a striking example. Before the inauguration of the East India Company, the sub-continent sustained an estimated 100,000,000 people. By 1850 the population had doubled and today, with close on 440,000,000 hungry stomachs, the sub-continent is facing one bleak starvation after another. China's 500,000,000 ill-fed multitudes are increasing by some 6,000,000 a year. Fifty years from now, at the present rate of increase there will be something like 900,000,000 Chinese, and in the same span of time India and Pakistan will have a total citizenship of 750,000,000 people.

Already India ranks among the poorest countries in the world. Her gross national income barely amounts to six pounds per head per year, while the calorie intake per head is less than 1,000 every 24 hours. Perhaps Julian Huxley puts the problem in the aptest terms when he said, 'the mere quantitative increase in numbers is creating a qualitatively new situation for the human species. And all the ameliorative measures aimed at increasing production are merely palliatives. In two or three generations they will be overtaken by human multiplication and the world will be where it was before, only a little worse off, since most of its vacant spaces and unused resources will have been taken up.'

Already there is a feeling of resentment among Asian intellectuals who make no secret of the fact that the vast spaces of Canada and Australia could be brought under ploughs held by Philipinos, Chinese, Indonesians or Indians. However, it would only be a stop-gap solution, for as Mr. Huxley points out, in 20 years' time Asians would be proliferating at an even greater rate.

Another factor is the mounting population pressure in the Soviet Union. The U.S.S.R. has embarked on a planned programme of population expansion. By 1955 Russia's census takers will count 212,000,000 people and by the end of this century there will probably be some 300,000,000 semi-Slav-Asiatics.

In Africa, too, populations are increasing faster than ever before. They are of course still of far lower density than the over-populated regions of the East, but with improving health conditions the net rate of increase has already greatly accelerated and it may be expected to continue to do so.

It is true that science in its application to agriculture is opening the way for greatly augmented production, but this in itself demands methods calling for an accelerating degree of technical knowledge and skill. Unfortunately experience has shown that with primitive peoples any increase in productive capacity too often translates itself into a rapid increase in population rather than a rising standard of living.

Today there are approximately 2,300,000,000 people in the world. Demographers calculate that in 50 years' time at the present rate of increase it will amount to 3,000,000,000, two-thirds of which will be Asians, and if things remain as they are, increases will continue in geometric progressions. Ultimately a time must come when natural checks in one form or another will come into play unless some means can be found of limiting population increase. Indeed, more than one demographer has pointed out that the present war in Korea is but a symptom of what is likely to occur on an increasingly large scale until and unless the population problem is solved.

FAO and crop protection

IT is indicative of the general trend in this world of conflicting ideas and confused thinking that there should be overlap of activities in international collaboration in agriculture. The founding of FAO as the outcome of the Hot Springs Conference in 1944, and its subsequent incorporation into UNO was rightly hailed at the time as an event of great importance.

It was hoped at the outset, and we think rightly, that the new body would assume leadership in international agricultural affairs and prove the source from which new ideas and new movements would spontaneously flow. In fact, it would fulfil the role which David Lubin originally designed for the now defunct International Institute of Agriculture, which for so many years led a tenuous and somewhat precarious existence among the shady walks and ornate surroundings of the Villa Borghese in Rome, terminated by the outbreak of war with Italy in 1940.

Few would gainsay the many admirable features of the work which FAO has so far accomplished. On many we have commented in preceding issues, but it cannot be denied that so far it has not fully achieved acknowledged leadership in agricultural

matters among the nations of the world. Its functions have overlapped with other organisations of UNO, notably with UNESCO, while it played only a secondary part in the organisation of the UNSCCUR conference.

The need for a firm lead in the international organisation of agriculture is nowhere better seen than in regard to phytosanitary matters, and the control of plant pests and diseases.

The recent phenomenal developments in these directions is common knowledge; the greatest have occurred in the U.S.A. and U.K. Enthusiasm for new preparations for the control of pests, diseases and weeds has swept through the American continent like a crusade. In the U.K. progress has been slower and more staid, but nevertheless very substantial. In continental Europe, despite the efforts of many eminent scientists, the application of new methods and material has lagged behind and elsewhere, with the exception of some brilliant work on tropical plantations, the effect has been negligible. What is happening in the Iron Curtain countries is still, like many other things, largely 'wrapt in mystery.'

Since the war, in Western countries, a number of national and international technical bodies have been set up to deal with matters in this regard, while numerous international conferences dealing with various aspects have been held. The latter have included the Crop Protection Congress held in Brussels in 1947, the Commonwealth Mycological Congress held in Britain in 1948, the second highly successful International Crop Protection Congress held in Britain in 1949 (the papers read at this have recently been published in volume form) and another congress held at Zurich in the same year. In May 1950 yet another took place in Rome with the title of the ' Premier Conference International pour l'Examen des Moyens de Lutte Contre les Parasites des Plantes ' under the auspices of a body called CITA (Confederation Internationale des Techniciens d'Agriculture). The most recent effort is the Fernhurst Conference, held so successfully last month, organised by private enterprise and reported in these pages. Truly an imposing and formidable list.

One outcome of these activities has been the recent formation of the European Plant Protection Organisation, upon which we commented in our June issue. We understand that FAO favours the setting up of similar regional organisations in other continental areas.

Obviously international congresses on this important subject are desirable at fairly frequent intervals, being given the rapid rate at which advances are occurring, but if they are held too frequently there seems to be some danger that they may outstrip the rate at which new knowledge accumulates and slow down the work of the researchers themselves, owing to the demands on their time which they entail.

To us it seems that there is need for a supranational authority which will assist the formation of regional organisations and coordinate their activities, including the holding of regional international conferences, and the organisation of mondial gatherings at not too frequent intervals. For this role FAO seems to be eminently qualified; indeed a recommendation somewhat to this effect is inherent in the proceedings of the 1950 Rome Conference referred to.

Let us hope that some such development may occur for there seems to be ample scope for it.

Fernhurst reflections

A POINT which emerged from the Fernhurst Conference, the concluding section of our report of which appears on another page, is the need for more fundamental scientific work on the physiological processes of insects and crops themselves. This alone can supply the data needed to enable the pests, diseases and weeds which threaten crops to be effectively controlled.

There are some who decry the use of artificial methods involving the use of chemicals for their control on the grounds that they involve interference with the balance of nature, and that by employing them we are in danger of raising up ' many other devils worse than the first.' They maintain that if these courses are persisted in man may eventually destroy himself and the crops he produces.

This argument, however, falls to the ground when we consider that all agriculture is essentially interference with the balance of nature. The very crops we grow and the farm animals which we maintain are the direct products of interference with natural processes. It is improbable that nature alone, unaided by man's interference by selection and breeding, could ever have evolved the high-yielding sugar cane variety, or rubber clone, the super long-stapled cottons, or the 2,000-gallon dairy cow, and it is certain that even if such forms were produced by entirely natural processes they could never become dominant in a plant or animal population without a large degree of interference by man to protect them from the competition of other forms.

The act of cultivation is itself a challenge to nature, and large tracts given over to the production of a single plant are the very antithesis of the natural intention, if indeed such a thing can be said to exist, for in nature competition between a vast conglomeration of plant and animal forms is the very basis of existence.

The intrusion of weeds among crops, the sudden appearance of new devastating pests and diseases

and so forth are merely manifestations of the results of human interference in natural processes.

Viewed in this light, it is not surprising that the introduction of new methods of controlling enemies of crops should bring in its train fresh and oft-times unexpected difficulties; since agriculture is essentially an interference with natural processes, each succeeding advance is but the logical outcome of the step which preceded it. And the further we go the more difficult and complex are the problems with which we are likely to be confronted. Nature is a resourceful and cunning antagonist; in response to our efforts she produces such phenomena as the scale insect resistant to or tolerant of hydrocyanic acid fumigation, or the DDT-resistant fly. But this is not to say that our efforts are misdirected, rather does it emphasise that if we are to circumvent her we must know as much as possible about the way things work. We want to know why, for example, the position of a chlorine atom in a benzene ring should so profoundly affect the toxicity of an organic compound to different insects, or why Parathion will not kill red-spider eggs, or why the substituted phenoxy-acetic acids compounds are so effective against broad-leafed dictyledonous weeds and leave monocotyledonous plants untouched.

These and many similar matters are still mysteries waiting to be unravelled and probably the greatest service which the Fernhurst Conference rendered was the way in which it high-spotted the need for more information on fundamental questions of this type if progress in crop protection is to be maintained.

Problems of weed control

POINT is given to the foregoing reflections by some remarks of Dr. L. M. Stahler, Senior Agronomist in the United States Department of Agriculture at Fernhurst, when speaking of chemical weed control in North America. The manner in which 2-4 D has gained general acceptance in the North American continent for the control of weeds in cereal crops must be accounted a major phenomenon. We are told that the total acreages treated with it in the year 1950 amounted to the well nigh incredible figures of 14½ to 15 million acres in Canada and 20 to 25 million acres in the U.S.A.

As is well known, weedicides of the substituted chloro-phenoxyacetic acid type, of which 2-4 D and Methoxone are examples, are very effective against a wide variety of broad-leaved annual and perennial plants but leave grasses untouched, and it has now been found in certain areas of the United States that consistent and persistent use of 2-4 D has already changed the weed population from an annual broad-leaved complex to an annual grass complex. The possibility of this occurrence, it may be mentioned, had already been foreseen by Prof. G. E. Blackman some time ago and was mentioned in a paper he read to the Royal Society of Arts in London in 1950, an abbreviated version of which appeared in our issue of June 1950.

In consequence, increasing importance is now being attached to the discovery of weedicides which are effective against grasses and much research is being carried out on this point. So far the most successful chemical discovered in this regard is trichloroacetic acid, TCA, which has already won wide acceptance for the control of grasses in the U.S.A.; it is estimated that some 12 million pounds of the sodium salt will have been produced in the U.S.A. in 1951. It is stated to be highly selective in its action and has been successfully used in controlling certain grasses in such crops as sugar beet, flax and certain legumes, and its advent is regarded in the U.S.A. as of real promise in connection with this problem.

The circumstance seems to be an admirable example of how each new discovery may be expected to open up a whole series of new problems.

Fertiliser use should expand

THE consumption of fertilisers in the United States for 1950 was recently announced. The figure is 18,346,132 tons, almost 2,000,000 tons more than the consumption in 1949 and, looking much farther back, nearly 16,000,000 tons more than American farmers used in 1901. Despite this remarkable expansion, soil scientists in the United States have recently suggested that fertilisers are still seriously under-used. Dr. Rost of the University of Minnesota estimated that in his state the seven major crops remove from the soil some 500,000 tons of plant nutrients and only 11% of this is replaced by nutrients in fertilisers. He considers that it would require over 1,600,000 tons of fertilisers to balance the nutrient budget of Minnesota soils; in 1950 this state totally used only 217,133 tons. Dr. Rost felt that it was not yet profitable to replace the total nutrient removal with fertilisers, but he thought that the gap should be narrowed—a trebling of Minnesota's fertiliser consumption per year would not be too much.

These facts and opinions from across the Atlantic have more than American significance. For years now fertiliser consumption in the United States has been expanding; the annual rate of expansion must have been highly satisfactory from the U.S. manufacturers' business viewpoint. Moreover, the United States in post-war years has not had to face food shortages of any serious kind; on the contrary, the world's dollar shortage created a food surplus situation and at one time it was commonly said that

America's grain stores were bulging. Yet with this background more and more fertiliser is used each year by the farmers, and at the same time the soil scientists—state servants and not men with interests in the production or sale of fertilisers—call for increases that would make the present rising curve of consumption look like a gentle slope.

In other parts of the world, not least in Britain, economic considerations are tending to slow down the rate of fertiliser expansion. Production problems, too, are making a somewhat negative contribution. There is considerable danger that fertiliser consumption may be stabilised at some level that is below rather than above 1949 usage. No doubt some scientists and administrators feel that the sulphur situation imposes a need for caution in urging the increased use of fertilisers. But such an attitude, though it may seem to have short-term merits, is surely wrong. Even if production is restricted by external factors, there should be no under-emphasis of the need to use more fertilisers. It is not salesmanship that sells fertilisers—it is education. Education must be ceaseless. It is far better for a farmer to know that he should use 20 tons of fertiliser although he cannot obtain more than 15 than it is for him to believe casually that 12 tons is quite enough.

Man-made weather

UNDER the above title some remarks appeared in these columns in our issue of May 1950, in which we propounded the query whether with the advance of knowledge mankind might be able to look forward to securing in the future a hitherto undreamt of control over weather conditions. In it we mentioned the efforts made to induce rainfall in the U.S.A. by seeding dry ice on to clouds from aeroplanes.

Recent developments in this direction now prompt the query whether the artificial induction of rainfall may not now be already in sight.

The pioneer workers in this connection in the U.S.A. were Dr. Langmuir and Dr. Vincent Shaefer, and their efforts are already fairly widely known to agriculturists.

In their experiments, first ' dry ice ' (or solid carbon dioxide) and later silver iodide particles were used as precipitants to start the formation of ice crystals in clouds, which is believed to be the initial stage in the chain of physical changes that leads to rainfall. A cloud at high altitude is regarded as a super-cooled mass of air super-saturated with water vapour, and just as a super-saturated solution often requires the stimulation of dust particles or a seeding crystal to start the precipitation of the dissolved substance, so a cloud is believed to require a ' rainfall agent.' Natural deposition of rain is caused, of course, by some abrupt change in the physical conditions of the surrounding atmosphere. Artificially-induced rain, therefore, is rain that falls from a cloud (a) that has been seeded with dry ice or silver iodide or some other agent, and (b) that has not, between seeding and the time of rain, been subject to natural atmospheric changes that would in any case have caused rainfall. The big difficulty is to decide when this second condition genuinely applies. There is increasing scepticism in America about the claims of the rain-making pioneers. Reports of the Congress hearings earlier this year showed that there is not yet general belief that scientists have in fact produced controlled rainfall. The idea of control by some Government agency was shelved and experimental work is to continue in a medley of official and private tests.

The less commercial rain-makers admit that it requires conditions when some natural rainfall would occur for cloud-seeding to be successful; in short, they claim to produce more rain than would have normally occurred or to cause it to fall earlier.

However, artificial rain experiments are not confined to the United States. In South Africa (*Discovery*, 1951, **12**, 7, 219-220) government research has been conducted since 1948. Ground generators for silver iodide smokes are now being used. As in America, the difficulty is to prove that rain would not naturally have fallen, but the most recent evidence is taking a conclusive shape. On four occasions when silver iodide could have been expected to induce rain, rain storms followed the release of the smokes; a north wind was blowing and the rain fell suddenly five miles south of the smoke release point and observers were surprised because rain did not seem likely.

All this is very interesting, and although we may be as far as ever from solving the problem of inducing rainfall in regions of low atmospheric humidity, is it too much to hope that where the relative humidity is high, but droughts are frequent owing to the low elevation of the land or some other cause, the artificial induction of rain by methods of this type may in the not too far distant future enter the range of practical politics? This type of thing is quite frequently encountered under island conditions in the tropics, for example, in some of the lower lying islands in the Caribbean or the Polynesian regions, and localities of this type provide manifest opportunities for future work.

THIS MONTH'S COVER

' The old order changeth and giveth place to the new !' Low volume spraying of an apple orchard by helicopter in the Midland counties of England.

(Photo: Pest Control, Ltd.)

A Farmall low-volume sprayer spraying cauliflower with a systemic insecticide

Problems of Low Volume Spraying Machinery

S. J. ZIMMER

The disadvantages of high volume spraying machines for the control of pests are cost, the need for water and the slowness with which they cover the ground. Low volume spraying, using either aircraft or mistblowers, may provide a cheap solution to some of the pest problems, but these methods themselves involve a set of new problems for the spray engineer, as outlined by our contributor.

THE spraying of crops in order to destroy rival plant life and insect pests is assuming increasing importance. Monocultural systems in established plantations give rise to conditions *artificially suitable* for the preservation and spread of pests. Economic considerations make it necessary to grow annuals and other short-lived plants in large blocks and repeatedly on the same site; in consequence the pests are becoming more numerous and destructive at just the time when it is necessary to produce more food.

Spraying is therefore being forced upon farmers to destroy weeds and to prevent the growth of insect colonies.

The older methods are inapplicable because, firstly, the cost cannot be borne by farmers, and secondly, because spraying as previously developed is incapable of dealing with very large areas. Therefore, in many countries much attention is being paid to developing spraying methods applicable to large areas of crops.

The chemist provides the materials to be used in the attack and there are now an enormous number of insecticides, fungicides and herbicides. The engineer working with the entomologist and the plant physiologist determines how to use the chemicals efficiently, but it must be admitted that so far efforts are lagging many years behind. The engineers are, to an extent, blameless for this since they need indications from the biologists, which have not always been forthcoming. Now, however, they are catching up and testing and designing machines to spray with known standards of precision at high speeds.

Aims in spraying

In the past the practical man's idea of efficient spraying was complete cover and perfect uniformity in distribution in any weather without damaging the crop. This cannot be achieved cheaply and it is now beginning to be realised that perfection may cost very much more than the increase in yield is worth.

It was only about 30 years ago that spraying with a mobile machine began to play an important part in farming. A beginning to power spraying was made in orchards, although hop gardens and vineyards were sprayed by hand as early as 1880, and in order to provide a thin uniform coat of material and to carry the spray up into the trees insectides and fungicides were diluted with large quantities of water.

When ground crop spraying began, the machines designed for tree spraying were modified to spray the ground, but no attempt was made, until about 1938, to design efficient and economic ground sprayers.

Tree spraying required the dilute spray to be thrown at the tree with a high velocity, in order to reach the top and to penetrate foliage and crevices in the bark; large quantities had to be used so that the trees often looked as though they had been dipped in a tank of insecticides or fungicides. The very large excess of spray used to drench the trees ran off on to the ground leaving a thin film which dried to give a deposit.

Only one general form of machine was used, in which large volumes of spray fluid were pumped at high pressure with a reciprocating positive displacement pump to break up the spray. In order to avoid frequent returns to base for refilling, the tank was made as big as the sprayer could carry and the tractor pull. The machines were, in consequence, heavy, cumbersome, expensive and power consuming. Similar machines were also used in early days for ground crop spraying.

The advent of weedkillers

As soon, however, as the selective hormone weedkillers, which must be used in a concentrated form, appeared, the engineers and biologists turned their atten-

tion to producing sprayers which could be tractor mounted and needed refilling at only infrequent intervals, and the low volume sprayer made its appearance.

Low volume sprayers

Low volume machines are, of course, by no means perfect in as much as it is necessary occasionally to resort to high volume spraying with other selective weedkillers (*e.g.*, DNOC) to kill weeds resistant to hormones which tend to become prevalent when hormones are used continually. On this account dual-purpose machines have been evolved which can be converted from low to high volume by changing the nozzle. When, however, a chemical which can perform the job done by DNOC at high concentration becomes available there will be no need to have dual-purpose machines.

Weedkilling in cereal crops

In cereal crops, low volume spraying of selective weedkiller has largely superseded traditional methods of weed control quickly and easily. The reasons are: firstly, the herbicides can be used at high concentration; secondly, the difference between a weed killing dose and a dose dangerous to the crop is wide and there is little danger of overdosing; thirdly, the boom is placed only a foot or two above the young corn so that there is little fear of drift of the spray droplets on to susceptible crops and there is no need to use a large amount of power in achieving satisfactory coverage; fourthly, the method of spraying is ideally easy for achieving a precise deposit and avoiding the needle like blades of young corn and hitting the broad-leaved weeds; and finally, it is not necessary to achieve a perfectly uniform and complete cover since the spray is absorbed into the plants.

Extension of low volume spraying

If only it were as easy to see the path to the successful application of low volume spraying methods to other crops, the large and heavy present-day spraying machines would quickly go out of use except in the rare instances when the type of deposit they give is essential to successful control of pests and diseases.

Apart from the cost and the difficulty of towing these machines through a crop, two major disadvantages prohibit their use among crops grown in large acreages. Firstly, apart from cereals, top fruit, sugar beet and potatoes, few crops are grown in the temperate zones that are of world significance. Many of the important food crops together with raw materials, such as cotton, are grown in the tropics where often there is little water available for spraying. Moreover, spraying a band the width of the ordinary spray boom at two to three miles an hour enables a sprayer to cover only a few acres per hour even if no time is wasted in refilling the tank every hour or so.

An instance which illustrates how useless conventional sprayers covering the ground at this rate can be in such conditions, is the control of blister blight on tea. The crop in Ceylon and India is often grown in blocks of a thousand or more acres, and during the monsoon season it might be necessary to spray every seven days approximately. Working 70 hours a week a single 2,000-acre farm would therefore require half a dozen high clearance crop sprayers together with a fleet of tankers to supply them with wash.

Helicopter spraying ensures that the spray is blown under and around the leaf surfaces

Scope for further research

We can accordingly summarise two main aims for further research on spraying machinery as follows: (a) to design machines which will enable land to be sprayed much more quickly than can be achieved with a high volume sprayer; (b) when the chemists can supply suitable materials and the biologists have decided the appropriate time and method in which they should be used, spray engines will be required to supply machines capable of applying very small quantities of material in a highly concentrated form so as to enable very many acres to be covered between two successive refillings of the machines.

Low volume spraying by mist blowers and aeroplanes

It is certain that low volume spraying, using either mist blowers or aeroplanes, cannot be as thorough as high volume spraying; on the other hand, it is many times as quick and far cheaper. It is therefore desirable to ascertain how far a reduction in the standard of spraying can be tolerated in return for the advantages of cheapness and speed.

Satisfactory range of coverage is essential and if that cannot be achieved by utilising the kinetic energy of the spray droplets themselves two methods can be used. Either a mist blower can project the droplets laterally in a blast of air; by this means it is possible to cover a swathe up to 100 yd. wide in each traverse. The alternative is to disperse the spray fluid into very fine drops at a height above the ground, using an aeroplane and allowing the drops to be carried sideways by the wind as the aeroplane flies across wind. In this way also a swathe width of 100 yd. can be obtained together with a forward speed of about 100 m.p.h. This enables the ground to be covered at an enormous rate. A drawback, of course, is that an aeroplane spends a lot of time turning at the headlands and has only a small tank capacity.

Limitations

It is probably possible by these means to spray at rates suitable for all crops and to carry out emergency sprayings which must be done quickly at short notice. It is in the matter of the quantity and quality of the spray deposit—*i.e.*, its 'position' and the amount and the

An Auster ' Aiglet ' aircraft demonstrating low-altitude spraying technique

degree of dispersion, that concessions to speed must be made.

By ' position ' is meant the actual portion of the plant or leaf which is sprayed. For example, with most aircraft sprays, all the drops land on the plant from above and only the upper leaf surface receives much spray. For a wind-borne fungus infection which itself lands on top of the leaves this form of deposit may be suitable.

An example of high-volume spraying; the K.E.F. ' Autoblast ' with one bank of nozzles spraying fruit trees

But for insects which live and multiply in the shade of the leaf an aerial spray is less effective. An exception will occur if a systemic insecticide which is translocated by the plant is being used and also if the insecticide has a partial fumigating action, *e.g.*, in the case of parathion where actual contact of the spray with the insect is unnecessary.

An exception to this also occurs in helicopter spraying, since in the violently turbulent conditions in the pressure cushion below the rotor, the spray is blown under and around the leaf surfaces and distributed all over the plant.

In orchard spraying with mist blowers it is difficult to ensure that the centre and top of the tree receive as large a dose as the lower outermost branches near the sprayer. The same defect occurs with high volume automatic sprayers. Since the top centre of the tree is the favourite insect dwelling place, often aptly called the ' pest nest,' future work must be directed to the removal of this defect.

Distribution

The amount of spray falling on a unit area or ' the dose ' is sensibly constant for sprayers with booms a few inches above the crop and with suitably spaced overlapping nozzles. A defect of all the cheaper methods of spraying, however, is that it has not yet been possible to get uniform distribution at all points of the band sprayed in one traverse. The helicopter gives a very intensely covered band underneath the rotor and a wide thinly sprayed band stretching away to either side. Notwithstanding extensive experiments, no means have yet been devised of smoothing out this non-uniformity even if the swathes are overlapped. Fixed-wing aircraft are even worse unless they fly very high, and this in turn has its disadvantages. Near the aircraft track the dose may be several times as great as that 50 yd. away and a hundred times as great as that at the far side of the swathe.

A case in which wide variation in deposit density is undivided except for the ensuing waste of material is the spraying of marshland against malarial mosquitoes. In such conditions, coupled with hand applications of spray to pin-pointed breeding spots, both aircraft and mist blowers of the Buffalo type have been used to eradicate mosquitoes almost completely in some areas.

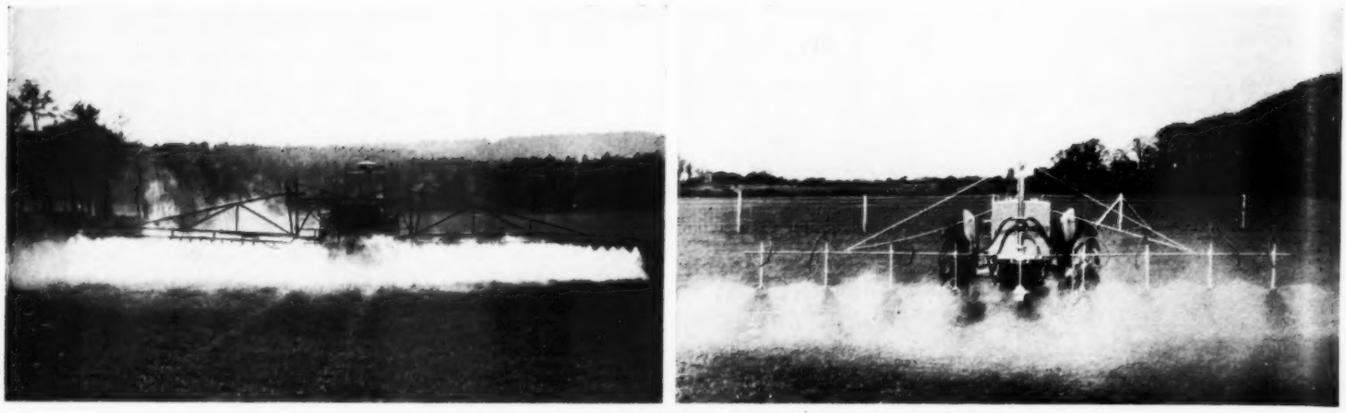
Usually, however, it is essential that the deposit density should lie between the minimum quantity needed to kill the pest and the maximum quantity above which damage to the crop begins to occur. These limitations must, in fact, largely control the design of all low volume spraying machines.

Then in applying lime-sulphur to apple trees the least overdose damages the tree as well as killing the scab-fungus; if large overdoses occur they may cause the death of the tree. An essential factor in low volume spraying technique is therefore to ascertain the limiting values of the deposit density and to ensure that they are observed.

Degree of dispersion

By dispersion is meant the spread of the spray fluid on the foliage. If a leaf is picked and the spray deposit is seen to lie in two or three widely spaced large drops, then the spray is said to be coarsely dispersed. If, on the other hand, it is covered with a uniform film in which individual droplets are not easily seen then the spray is said to be finely dispersed.

Systemic insecticides need not be finely dispersed as they are absorbed and translocated by the plant and this ensures that the dose is carried to all parts of it. On the other hand, preventive fungicidal sprays must normally be very finely dispersed and the unsprayed areas between individual droplets must be very small otherwise fungus spores will germinate there. When spraying with DNOC against desert locusts, a coarse dispersion is adequate because the adult locust is quite large, while one drop of DNOC spray is sufficient to ensure a kill. On this account the interval between individual droplets can be quite large. If, however, the locusts are massed in depth either flying or feeding, a denser spray is needed since when the uppermost locust have been dosed



Examples of spray drift, particularly evident in the left-hand picture. The machine on the right is fitted with underleaf spraying equipment

sufficient spray must remain to reach those lower down.

Weather conditions

All low volume spraying depends to a considerable extent on weather conditions and particularly on the prevalent wind. Very small drops must be used to achieve an adequate dispersion; drops as small as 100 microns in diameter (*i.e.*, approximately four-thousandths of an inch) are about an average size for low volume sprays. These are very nearly permanently air-borne and move with the least draught.

A few figures help to illustrate this. Thus if a gallon of spray fluid is dispersed in 100-micron drops and spread uniformly over an acre the droplets will be scattered at the rate of approximately two on each square millimetre of surface. If the drops were 200 microns in diameter, however, there would be only 25 on each square centimetre, *i.e.*, they would probably be 2 millimetres away from each other; such a degree of dispersion would not be effective for the control of fungus diseases. When it is realised that an acre of land under crop may carry 10 or more acres of leaf surface, it is obvious that subdivision of spray fluids into very small droplets is necessary when using concentrated solutions or suspensions.

Small droplets are at the mercy of the wind and the power of the wind is very frequently underestimated. Thus, a fresh breeze, blowing through an orchard has an energy content of several h.p. Accordingly, it is now common practice in America to spray at dawn and dusk when air movement is least in order to take advantage of weather conditions most suitable for low volume spraying.

Conclusions

The many problems confronting the spray engineer may be broadly summarised as follows: (1) The improvement of spray nozzles for low volume work, concerning the performance of wind in producing drops of a required size little is as yet known. (2) Mist blowers and aircraft sprays must be designed to achieve far greater uniformity in deposit density. (3) To meet the requirements of the biologists, means must be devised of getting sprays to penetrate below the leaves as well as wetting the upper surfaces. (4) Either the dependence of methods of spraying on weather conditions must be reduced or, alternatively, more knowledge must be made available concerning the effect of weather conditions on spraying efficiency, so as to give precise indication as to the conditions most favourable for spray applications. In this connection there is also need for more precise information concerning wetters and stickers for insecticides and fungicides.

New machines in which the attempt has been made to solve some of these requirements are reported to be nearing the production stage, and there seems reason to hope that in due course greatly improved machines will appear in which early mistakes and defects will have been satisfactorily corrected.

Photos: p. 331, 332 and 334 (left), Pest Control Ltd., p. 333, Shell Chemicals Ltd., 334 (right), E. Allman & Co.

Locust Reports from Pakistan

A conference which started in Karachi on June 21 was called by Mr. Abdus Sattar Pirzada, Minister for Food and Agriculture, Pakistan Government, to consider the locust situation in West Pakistan. Chief ministers, agriculture ministers, finance secretaries and heads of agriculture departments of all the Provinces and States in West Pakistan took part in the discussions.

The conference reviewed the locust situation throughout west Pakistan and the control work done at central, provincial and state levels, and aimed to adopt measures to co-ordinate and intensify anti-locust work.

A report issued by the Director of Plant Protection, Pakistan, for the fortnight ending June 15, said:

'Spring breeding has practically finished in Pakistan except in some places in the uplands of Baluchistan and the N.W.F.P. which are also expected to be cleared shortly. The eastward migration of swarms continues. Two more swarms have entered Baluchistan from Afghanistan. In the Bahawalpur State, some swarms appear to have come from Rajasthan. Some of these seem to be mature and, with the recent rainfall in Bahawalpur, breeding is expected shortly.'

It added: 'The infested areas in the Hazara district of the N.W.F.P. have been cleared.

'In the uplands of Baluchistan, control operations have concluded in the Ziarat Valley, but are being continued in the Quetta-Pishin district where the situation is well under control.

'The hopper destruction work carried out in the Punjab during the last three months or so has ended, except in Campbellpur where slight infestation still exists. Sakesar hills, which border the common boundary of the Campbellpur, Mianwali and Sargodha districts have also been cleared of the hoppers. Considerable swarm activity has been reported from the Punjab, Sind and Bahawalpur.'

The Fernhurst Conference

Part II

In our previous issue we reviewed generally the proceedings of this important crop protection conference and summarised Sir John Russell's opening address and the discussion thereon. Below we give a summary of the proceedings at the subsequent sessions.

Chemical weed control

THE second session of the conference was held under the chairmanship of **Dr. W. A. Sexton**; it was devoted to problems of chemical weed control and opened by **Dr. W. G. Templeman**, who reviewed the existing state of knowledge on the subject. In his paper Dr. Templeman pointed out that while chemicals have been used as herbicides for a long time the most striking advances have occurred during the past ten years. Early selective herbicides included copper sulphate, sulphuric acid, kainit, and calcium cyanamide, while the non-selective ones included the arsenicals and sodium chlorate. Dinitro-ortho-cresol was developed between 1932 and 1937, while naphthyl acetic acid was found to be effective against charlock in oats in 1940.

The substituted phenoxy-acetic acids were first introduced in 1942, independently at Jealott's Hill and in the U.S.A., and have been widely adopted; in 1950 14,566,000 acres were treated with 2-4 D in the Canadian prairie provinces.

At high concentrations they can be made to kill all plants, and their selective action occurs only at low concentrations. Grasses are very resistant to them, and the discovery in 1941 that isopropyl-phenyl-carbamate is very toxic to grass seedlings gave a lead for research which may yield effective grass killers.

An important development during the past decade has been the use of dinitro-secondary-butyl phenol (DNBP) as a selective weed-killer in leguminous crops, widely used on lucerne and clover, while waste oil products, such as stove oil and Stoddard oil, have given good control in carrots and other umbelliferous crops.

Since the war pentachlorphenol, the cyanates, the inorganic salts of trichlor-acetic acid (for grasses), ammonium sulphamate, methyl bromide, phenyl mercuri-acetate and sodium isopropyl xanthate have all come to the fore as specific for certain weeds and others are certain to appear in due course.

He went on to discuss the formulation of weed-killers and, in particular, the relative efficacy of Methoxone and 2-4 D, the former being widely used in Europe and the latter in the U.S.A. where 2-4 D is employed in much lower concentrations than is Methoxone in this country. Methoxone is used in the form of the relatively very soluble sodium salt, while 2-4 D is predominantly used in the form of esters or amines.

This led to consideration of the use of mixed weed-killers which may have considerable possibilities.

The possibility exists that the use of weed-killers may lead to the evolution of resistant forms of weeds, though so far no signs of this have been observed, while the continued use of one form of weed-killer may lead to the elimination of susceptible species and the great increase of resistant types. To meet the latter difficulty Blackman has suggested that farmers should practise rotational use of weed-killers on weedy fields.

The possibility of applying weed-killers in association with fungicides, insecticides or fertilisers also arises. It would have certain advantages, but there are so many disadvantages that they more than nullify the advantages.

An important recent discovery at the Boyce Thomson Institute is that sodium 2-4 dichloro-phenoxy-ethyl sulphate is not phytotoxic when sprayed on the leaves of plants but is toxic when applied to the soil. It may be that this compound is broken down in the soil to give a toxic compound. It opens up interesting new possibilities.

It is hard to see the way in which weed control will develop, but with new knowledge suggestions for new methods will certainly appear, while new compounds and fresh ways of using existing ones will continue to emanate from chemical industry.

Discussion

In the discussion which followed **Dr. L. M. Stahler** reviewed the position in North America. The discovery of MCP and 2-4 D are now recognised as among the most important contributions of science to agriculture. The acreages treated with 2-4 D in the U.S.A. and Canada in 1950 were estimated at 20 to 25 million acres and 14 to 15 million acres respectively. The introduction of the low volume sprayer had greatly facilitated development; a single machine can now treat up to 160 acres per day.

Delegates heard papers delivered in the conference tent at Fernhurst

There had also been phenomenal development of aeroplane spraying. Single-motor light planes are used, flying at 80-100 m.p.h. at a height of 4-12 ft. above the crop, and covering a swathe of 35-40 ft. They use 3 quarts to 5 gallons of spray fluid per acre, and can treat 1,000-1,800 acres per day. Diesel oil or No. 1 fuel oil is most commonly used as a diluent. In rice cultivation aeroplane application of 2-4 D is exclusively used for weed control.

Experiments have conclusively shown that MCP has advantages over 2-4 D in the control of certain broad-leaved annual and perennial weeds in flax and pea cultivation. The reason why it is not more popular is the much higher cost in America. Dr. Stahler thought that the lower rates of usage of 2-4 D in America were due to American farmers being content with partial control of weeds, while European farmers demanded complete weed suppression.

Many new herbicidal materials are appearing. 2,4,5 T is now widely used in controlling woody perennials, often in mixtures with 2-4 D. TCA (trichlor-acetic acid) has met wide acceptance for the control of grasses. 12,000,000 lb. of the sodium salt will be produced in the U.S.A. in 1951. It has proved highly selective in removing annual grasses in sugar beets, while flax and certain legumes are tolerant of it.

As Blackman predicted, continued use of 2-4 D has already changed the weed population in certain areas of America from an annual broad-leaved to an annual grass complex, and TCA is considered a real advance in handling this problem.

Many other new compounds are being tried. They include IPC (isopropyl-n-phenyl carbamate), Endothal (disodium 3, 6 endoxohexa hydro-phthallate), CMU (3p chloro phenyl-dimethyl-urea) and a number of others. For control of aquatic weeds Rosin amino D acetate (RADA) has been found very effective against algae and is replacing copper sulphate in this use.

In the U.S.A. and Canada weed control research is closely integrated and co-operative, and workers there look forward to an agricultural economy where all herbage is strictly controlled.

Synthetic organic insecticides

At the third session the topic discussed was the value and limitations of synthetic organic insecticides. The chair was taken by **Dr. C. W. Farsted,** Senior Entomologist at the Dominion Research Institute at Lethbridge, Alberta, and the opening paper contributed by **Mr. J. H. Stapely,** in which he reviewed the present position of knowledge in this regard.

He emphasised that the discovery of so many powerful insecticides of recent years had led to the bewilderment of the grower and laid a heavy responsibility on the research worker. Sometimes the enthusiasm of the manufacturer outpaced the accumulated evidence of the value of the recommendations made, and lessons should be drawn from past experience. New compounds should replace established insecticides slowly and only after adequate trial, while research workers should turn their attention to new compounds of higher toxicity.

Among new techniques the systemic insecticides, which only become toxic when absorbed by the plant and translocated in the sap stream, probably offer the greatest prospects of development as newer and safer types are revealed by research.

The best known of the newer insecticides is DDT, the chlorinated hydrocarbon derivative, there are many others *i.e.* benzene hexachloride (BHC). Another type is the phosphorus-containing organic insecticide such as Parathion. Many of them are selective in their action. Thus DDT is effective against a large number of caterpillars as well as some weevils and beetles; BHC is effective against some of these and also is particularly useful against soil-inhabiting insects, notably wireworms, where spectacular results have followed its use, while it is also very valuable in locust destruction. It has the disadvantage of tainting certain crops. Parathion is the best known of the phosphorus compounds, especially valuable against mites of the red spider type, though not against their eggs, and against aphids. It is, of course, very toxic to humans. A recent interesting discovery was that Parathion could be used to control certain species of eelworm.

Sir John and Lady Russell. Sir John delivered an address at the first session of the conference

The limitations to the use of insecticides are that (1) they may harm beneficial insects as well as killing those which damage crops; (2) they may have a harmful effect on the crop and the soil in which it is grown; and (3) they may be injurious to man and domestic animals who consume them. All these risks have to be guarded against.

The new products have stimulated new methods of application, notably the use of aerosols and smokes as well as low volume or concentrate spraying, while the discovery that insecticidal activity may be associated with molecular structure has stimulated research. However, until much more is known about the way such compounds work in this connection, empirical methods of screening chemicals must continue to be used.

Discussion

During the discussion some interesting details were given by **Mr. O. B. Lean,** who had recently returned from Persia, concerning the present campaign against the desert locust, which is causing so much anxiety in that country at present. BHC has been particularly effective when employed in the form of baits, while Aldrin, which is being used in the form of dusts applied by American operators from aeroplanes against flying swarms, has been shown to have valuable 'knock-down' properties.

Professor D. J. Kuenen, of Leiden University, Holland, emphasised the effect of the application of these insecticides on the balance of nature. They were liable to upset both physiological and ecological conditions in the growing crops, and these must be considered separately in each case. Moreover, it is essential that we should have more knowledge of insect biology and especially insect physiology.

Senor R. de Soto, of the Ministry of Agriculture, Uruguay, described measures being taken for the control of locusts in that country.

Dr. Farstad mentioned the large-scale work against grasshoppers on cereal crops in Canada, using Aldrin and BHC. Aldrin was somewhat slow in its action. He also

Mr. S. W. Chievely (*left*) **with Mr. T. Ainslie-Robertson, Chairman of Plant Protection Ltd.** (*centre*), **and Dr. Alexander Fleck, of I.C.I. Ltd.** (*right*), **outside the conference tent**

touched on the use of BHC as a seed dressing against wireworms.

Dr. Rivnai referred to the use in Israel of BHC against ' Dudi,' a leaf miner which passes certain stages of its life in the soil. He also mentioned the problem of controlling Mediterranean fruit fly.

Mr. H. J. Page mentioned that in the West Indies the use of BHC for the control of froghoppers (*Tomaspis*) on sugar cane had been followed by an increase in the population of stemborers.

Fungicides

The fourth session of the conference was devoted to the consideration of fungicides. The chair was taken by **Dr. J. Smith**, formerly Director of Agriculture in the Sudan, and the session opened with a discourse from **Mr. J. F. H. Cronshey.**

He reviewed the history of the use of fungicides, pointing out that it largely depended on the development of effective methods of testing them. Before the 1914-18 war copper and sulphur treatments were firmly established, while during the war organo-mercurial seed treatments first began to be studied. The development of a large range of foliar treatments is remarkably recent. This was probably due to the absence of methods for rapidly testing new materials, and the fact that laboratory tests did not always give reliable correlation with field performance. Many attempts have been made to bridge the gap and the present technique is a combination of laboratory tests and semi-scale field trials.

Numerous new substances have come forward, examples of which are ' Ferbam,' ' Ziram ' and ' Nabam,' the organo-mercurials, glyoxalidine and others. New diseases have been brought under control. Many of the new fungicides are far more active than the old, but the older fungicides are cheap and the newer are expensive and have not permitted reduction of costs to the grower. One important point has been the phytotoxicity of the older fungicides to certain crops and this has helped to increase the popularity of certain newer fungicides. Thus, damage to potatoes and tomatoes by copper sprays has led to the widespread use of thiocarbamates in the U.S.A. Another is the reduction of visible deposit on fruit and ornamental plants which their use enables. A large amount of work has been done on wetters and stickers for fungicides, but in practice the use of these materials is still an art rather than a science.

Seed treatment has made great advances, the most notable being the use of dusts and the development of the organo-mercurials. Originally developed to kill fungus spores on the seed, the method has been used for a much wider range of purposes. Moreover, some materials originally devised for foliage sprays have proved particularly valuable for seed treatment.

The clarity in the development of seed treatments is a marked contrast to the confusion which still prevails in regard to foliage treatment.

New methods and new techniques are beginning to appear, and an enormous number of chemicals are available. Probably further new methods will be found when techniques are devised to disclose them.

Discussion

In the discussion considerable stress was laid on the need for the development of reliable wetters and stickers, especially when the question arose of applying fungicides under wet conditions. **Mr. J. Lamb** emphasised the importance of this aspect in relation to the control of blister blight disease on tea in Ceylon.

Virus diseases

At the fifth session of the conference the subject considered was plant virus diseases. The chair was taken by **Dr. G. H. Cunningham**, and the opening speaker was **Dr. Kenneth Smith.**

At the outset he emphasised the importance of viruses to the human race. Not only were they the cause of many serious diseases of man and the domestic animals, but they took heavy toll of many crops. Instances were potato virus, which annually caused the loss of over a million tons of potatoes, the swollen shoot complex which is devastating cocoa in West Africa, sugar beet yellows which is an ever-present threat to sugar beet in East Anglia, and peach virus disease in the U.S.A. At present citrus growers all over the world were faced with the virus disease known as ' Tristeza ' or ' Quick Decline.'

Many viruses depend upon transmission by an insect vector so that control is often an entomological problem also; it is made more difficult as a small number of insects can cause heavy infections.

Control can be greatly aided by good farming hygiene, by inspection and field certification schemes for planting material, and by the isolation from infection of healthy susceptible crops.

The first essential is to ensure that the planting material is virus-free. One method of achieving this is to build up a nucleus stock of virus-free plants kept under virus-free conditions.

Viruses in carrier plants can be detected (a) by inoculation into indicator plants, and (b) by the use of a specific anti-serum. Indicator plants give a rapid and characteristic response to a virus which may be symptomless in the plant to be tested. The selection of a suitable indicator is largely a matter of trial and error.

The serum test consists of injecting the test virus into the veins of a rabbit. The rabbit is then bled and the anti-serum collected. This anti-serum only reacts with the specific virus and gives a quick and reliable means of recognising it.

Up to the present no great amount of success has attended attempts to control virus diseases by attack on the insect vector, although in a few cases good results have followed. The best control

has been achieved in confined spaces, such as greenhouses by the use of fumigation. It is possible that more success will be achieved in the open field through the use of systemic insecticides.

Sometimes the insect vector can be circumvented by careful selection of the planting site and the time of planting. In America insect vectors are warded off by the use of screens and cages, while experiments in Germany have shown that a trap crop may be useful in the control of beet leaf crinkle.

The production of virus-resistant strains of a plant is long-range work, but there are examples of successful control by this method, *e.g.*, the production of curly top resistant varieties of sugar beet in the U.S.A. and of sugar-cane varieties resistant to mosaic diseases in Java and the West Indies.

There is also the possibility of inducing immunity by vaccinating a plant with a mild strain of a virus to keep out virulent strains of the same virus, but this is at present only of academic interest, although it may have practical developments in the future.

There are two methods of curing virus infections, (a) by heat treatment, and (b) by chemicals. Method (a) has been successfully applied by Kunkel in America to peach trees infected with virus diseases. Little work has been done on method (b), but there are some indications that are not unpromising.

Discussion

In the discussion **Mr. J. D. Jameson**, of the Uganda Department of Agriculture, stressed the growing importance of virus diseases in the tropics and mentioned Dr. H. H. Storey's work on the production of strains of cassava resistant to cassava mosaic which has had a great effect on the cultivation of that crop in East and also West Africa.

Mr. S. W. Chievely, Managing Director of Plant Protection Ltd.

Dr. Posnette gave some details of the work on the swollen shoot virus on cocoa at the West African Cocoa Research Institute. He also pointed out that the problems of controlling virus diseases on tree crops differed essentially from and were more difficult than those of dealing with such diseases in annual crops. He touched on the factor of tolerance and the importance of the ' Quick Decline ' diseases of citrus.

Professor van Slochteren, Director of the Bulb Research Institute at Lisse in Holland, spoke on the serological method of diagnosing virus diseases, and mentioned that horses were being used in Holland for the production of serum for diagnostic purposes.

Factors limiting progress in protecting crops

The final session of the conference was devoted to factors which at present were limiting progress in protecting crops from pests and diseases. The chair was taken by **Sir Harold Tempany**, Editor of this Journal, and the opening address was given by **Dr. E. T. Holmes,** Director of Research for Plant Protection Ltd.

At the outset of his paper Dr. Holmes enquired why it was, being given the great losses at present experienced from preventible pests and diseases and the great advances in knowledge of recent years of methods of attack on problems of control, that crop protection measures are not more widely used ?

The reasons, he thought, were various. The main needs seemed to him to be as follows:

(1) More fundamental knowledge and data on the biological life-history and physiological processes of pests.

(2) The production of more effective and safer chemicals at economic prices for the control of pests and diseases.

(3) The production of more and more appropriate machines for the application of proved chemical measures for the control of pests and diseases.

(4) More and better co-operation between the various bodies of workers in the different fields, and more and better education in the widest sense to the advantages to be derived from the application of plant protection measures.

He concluded that universities and research stations must be encouraged to investigate fundamental biological problems bearing on control measures, students should be encouraged to tackle such problems, and more thought should be given to assigning priorities in the choice of subjects.

Dr. E. T. Holmes, Research Director for Plant Protection Ltd.

In regard to the production of new and better plant protection chemicals, a fundamental difficulty was the lack of knowledge about the relationship between chemical constitution and biological activity in these fields. More physiological and testing work was needed before the essential broad generalisations could begin to emerge.

In regard to machinery, manufacturers needed more precise definitions from the scientists of the biological, chemical and engineering conditions to be satisfied. There was also need for more imagination and skill in tackling the problems and, in regard to overseas countries, more practical experience of conditions was wanted.

In regard to co-operation and education, all research workers should co-operate in sharing the results of their work as soon as practicable while techniques of proved value should be brought to the attention

Dr. Poutiers, of the French Ministry of Agriculture

of growers and farmers by all the means available, including the spoken and written word and especially by practical demonstration.

Discussion

In the discussion **Dr. R. Poutiers,** Chef du Service de la Protection des Vegetaux in the French Ministry of Agriculture, spoke of the measures for the control of various pests and diseases of crops in France, and discussed the French scheme for the certification of crop protection products. **Sir H. Tempany** emphasised the importance and difficulty of making methods of combating pests and diseases known and available to primitive peasant growers in tropical countries, who produced so large an amount of the product coming from them. He emphasised the importance of the correct psychological approach in this connection.

Dr. Galley, of the Agricultural Research Council, spoke of the work in progress in the U.K. under the A.R.C. and also commented on the problem of putting over the results to peasant growers in connection with swollen shoot control in West Africa.

Dr. R. A. E. Galley, of the Agricultural Research Council

Many other speakers endorsed the views put forward by Dr. Holmes and gave the results of their experience under a wide range of conditions. There was general agreement concerning the need for closer collaboration between scientists and planters, and above all for improved facilities for bringing home the results of research to planters and farmers.

Conclusion

The demonstration of recent British machinery for applying insecticides, fungicides and herbicides to crops which followed the closing session was watched with great interest by the assembled delegates. Photographs of some of the machines exhibited have already appeared in WORLD CROPS.

The termination of the conference was marked by a dinner at which **Mr. S. W. Chievely** (Managing Director of Plant Protection Ltd.) thanked the numerous delegates, many of whom had come long distances in order to be present, for their attendance; he hoped and believed that the conference would be productive of useful results.

There is no doubt that the conference was eminently successful. Its results should become increasingly manifest as time permits the facts and ideas which emerged to be assimilated and translated into practice.

Photos pp. 338 (right-hand column) and 339, 'Farmers' Weekly,' London.

Soil Acidity and Liming with Tropical Crops

H. L. RICHARDSON

Lime is universally recognised as a valuable soil amendment in temporate countries, but it does not necessarily follow that this holds true for all conditions. In this paper the author draws attention to some of the dangers attendant on the use of lime in the tropics.

FOR those who have learned their agriculture in temperate climates, a new approach to the problem of liming is needed in the tropics. In Britain, one of the first things we ask about a soil is, 'Is it acid?'; and if the soil is acid, one of the first things we do is to lime it. In the tropics, liming an acid soil is sometimes the last thing we should do! This may be simply because liming is not needed on the soil and with the crop under study, and the application of lime is a useless expense. Where one is faced with the poverty of peasant farmers, as in the tropics, every unnecessary expense has to be avoided: it will be hard enough for the cultivator to find money even for treatments that may greatly improve his crops. There is also the possibility, which amounts to a real danger on some soils, that liming may actually do damage, and damage that will last for years.

Many cases of 'lime-induced chlorosis' have been reported. It is by now well established that when some trace elements are at or near the margin of deficiency, then heavy liming is likely to decrease the availability of the element and to cause symptoms of deficiency to appear. It is likely that many tropical and sub-tropical soils, in heavy rainfall areas, suffer from such deficiencies, and they should only be limed after the most careful consideration.

Lime-induced chlorosis is not the only type of damage caused by liming on tropical soils. This is not a thing one reads much about in the literature: if a man has ruined a crop or a piece of land by over-liming it, he is unlikely to write to *Nature* about it, but rather he hopes that his mistake will sink into oblivion. However, by way of what may be called 'gossip,' I have gathered that over-heavy liming is being freely advocated in tropical countries, by people whose experience is limited to this country; and that some serious harm has actually been done, as well as a good deal of money wasted by injudicious applications of lime. Hundreds of African soil samples have been sent to this country for analysis, and recommendations have been sent back based on the conceptions of lime requirement that are current in Britain, but it is very doubtful how far these conceptions are valid in tropical Africa.

Need for a different approach

There are several reasons why a different approach to liming is needed in the tropics and sub-tropics. One is that many tropical crops were evolved and selected under

high-rainfall conditions on soils that were naturally very acid. Consequently, these crops may actually prefer acid soils—as do heaths and rhododendrons in this country. Tea is an outstanding example. I do not remember that anyone mentioned it to me in England, but when I visited Assam I was soon informed that one thing which must not be done is to lime a tea soil. In the early days of tea-planting, managers fresh out from Britain had tried liming these very acid soils to neutrality, with disastrous results to the tea crop.

Lime and trace elements

Another reason why liming may be dangerous on leached tropical soils has already been referred to: many of them may be deficient in trace elements, as well as in major nutrients. Although heavy liming is beneficial with molybdenum deficiency, it is bad where there is a shortage of almost any other element—particularly boron, iron, manganese, copper or zinc. Yet another reason for caution in liming is the relatively small buffering ability of many tropical soils. Some are extremely sandy; others, although they appear heavier in texture, contain clays with a lower buffer capacity than the clays of temperate soils. Thus, even a little lime can produce a considerable change in pH, and a dressing that would appear normal in this country may raise the reaction too far in a tropical soil.

It is not suggested that lime should never be used in the tropics: on some soils and with some crops a little may give useful yield increases. Heavy alluvial soils will need more lime for a given degree of acidity than the lighter upland soils. The use of lime alone is generally undesirable, but where fertilisers are used on very acid soils, they may give better results with moderate liming. More field experiments on these problems are badly needed.

Need for caution

On what may be called normally acid soils with a pH around 5.0, groundnuts is the only crop commonly grown in the tropics and sub-tropics which is likely to be in real need of lime. And with groundnuts particular care is necessary because the crop is susceptible to trace element deficiency. Cotton, bananas and sugar cane have sometimes been found to benefit from liming, although cane will tolerate a very high degree of acidity. An improved variety may give the best results at a particular level of soil reaction, and this level should then be maintained by applying as much lime as is needed—not more.

Conclusion

One object of this communication is to urge that soil chemists advising on tropical agriculture should forget much of what they have learned in this country about lime requirements and proceed with great caution until more is known about the needs of tropical soils. It was well said, in the recent FAO bulletin on ' Efficient Use of Fertilisers,' that in liming one should not aim at changing the pH more than one unit. A tropical soil with pH 4.0 may safely be limed to pH 5.0, whereas to raise the pH to 6.5 or 7.0 might be harmful.

Perhaps I am inclined to err on the side of caution in this matter, but I would say when dealing with peasant farmers in the tropics, that one should only advise liming on crops and soils where field experiments have actually shown it to be beneficial. Even then one should think in terms of cwt. per acre, not tons per acre.

In temperate climates, where lime is cheap and plentiful, it is commonly used as a soil amendment or conditioner. The object is to bring the physical and chemical conditions of the soil nearer to those required by temperate crops, the supply of calcium as a plant nutrient being incidental. In the tropics, where most crops tolerate or prefer acid soils, and where lime is liable to be scarce and expensive, we are chiefly concerned with the supply of calcium as a plant nutrient. If lime is needed at all, smaller applications will be sufficient: it may be thought of more as a fertiliser than a soil amendment. Incidentally, the use of smaller rates of application will reduce the rate of loss by leaching, and this also will make for economy.

American Tung Oil

New Plantation Area Opening Up in Southern Mississippi

A large part of America's supply of tung oil, an important ingredient in paints and varnishes usually imported from the Far East, has been cut off by the Korean conflict. A substitute source of the oil is now being developed within the United States in the southern part of the State of Mississippi, where a new 240-acre tung tree plantation is taking shape.

Located in an area where tung trees flourish, a 50-mile wide belt along the Gulf of Mexico extending from the Mississippi River to the State of Florida, the plantation will produce its first tung oil after three years, when the oil-bearing nuts are first gathered.

The owners of the new plantation combined land clearing with pulpwood production, selling to pulp mills much of the felled lumber. The sale of the pulpwood easily paid for the clearing and preparation costs of the plantation.

An International TD-9 crawler tractor and Isaacson bulldozer was used to knock down the trees, all pines about 35 ft. tall and from 6 to 12 in. in diameter. A few of the largest trees were cut off about 6 in. above the ground and the stumps were removed later by the bulldozer. The 240 acres were cleared in 40 days.

(A detailed article on tung oil cultivation and production appeared in our July and August issues.)

A pine tree is nudged out of the ground by an International TD-9 crawler tractor equipped with bulldozer during land clearing operations on 240 acres being prepared as a tung tree plantation in the state of Mississippi

Agricultural and Horticultural Problems of Brazil

D. A. TIDMAN, F.R.E.S.

The writer of this article is an entomologist who has recently visited Brazil. He records below his impressions of some of the entomological and mycological problems facing agriculture in that country.

BRAZIL, the largest autonomous country in the tropics, and the fourth largest in the world (it is 8,500,000 sq. km. in extent), extends from the tropic of Capricorn to the Equator. Only the states of Rio Grande do Sul, Santa Catarina and Parana in the extreme south and a small portion of Sao Paulo lie outside the tropics.

This enormous country, bigger even than the United States, may be divided into three fairly well-defined climatic areas: (a) the tropical, torrid or equatorial zone which lies between the Equator and parallels 10° N. and S., includes the states of Amazonas, Para, Maranhao, Piaui, Ceara, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, and parts of Goiaz, Mato Grosso and Bahia; (b) the sub-tropical zone which lies between parallel 10° S. and the tropic of Capricorn, includes the states of Sergipe, Bahia, Goiaz, Espirito Santo, Rio de Janeiro, Minas Gerais, almost all of the Mato Grosso and the eastern part of Sao Paulo; and (c) the temperate or mild zone which commences at the tropic of Capricorn and ends at the southern extremity of the country, embraces the southern part of Sao Paulo and the states of Parana, Santa Catarina and Rio Grande do Sul.

The first three zones may be further subdivided into regions of super-humidity, continental humidity and sub-humidity, while zone (b) is characterised by considerable temperature variations. The average temperature of the tropical zone lies between 26 and 28°C., the sub-tropical 23 to 26°C., and the temperate zone between 16 and 19°C. It is interesting to note that minimum temperatures have reached 10°C. below zero at Palmas in the state of Parana at an altitude of 3,400 ft.

Agricultural production

Apart from having the largest cattle population of any South American country, agricultural products sustain most of Brazil's population and directly provide a living for more than two-thirds of it. Yet the cultivated land is only about 37,000,000 acres, less than 2% of the total land area.

Due to the extreme range of climatic conditions, Brazil can boast a very representative selection of world crops and, as might be expected, problems in the pest control sphere are many and diverse. Much has been written about the cultivation of this country's crops and the various methods of marketing them; it is, however, with Brazil's insect and fungoid pests that this paper is concerned. A great number are susceptible to the newer synthetic insecticides and fungicides, whilst others remain problems to be solved only by diligent research both in the field and in the laboratory.

Leaf cutting ants

Before considering pests of individual crops a few words might be said about those insects which, without doubt, constitute the gravest menace to agriculture in Brazil—leaf-cutting ants. No crop seems to be immune from their attack and truly, as the Brazilians say, it is a case of '*Ou o Brasil acaba com a sauva, ou a sauva acaba com o Brasil*' ('Brazil must destroy the ant or the ant will destroy Brazil'!)

These ants, or 'Sauva' as they are called, include *Atta sexdens v. rubripilosa*, *Atta cephalotes* and *Atta laevigata*, the first named being the species of greatest importance from an economic point of view.

According to Imms, all *Atta* species are fungus-growers and fungus-eaters. The fungi are cultivated in special chambers below soil level and are usually referred to as 'fungus gardens'; they are practically pure cultures of the fungi concerned, being assiduously weeded and tended by the ants. Neither free aerial hyphae nor any type of fruit body normally develop. In appearance a fungus garden is a sponge-like mass of leaf fragments and, in some cases, insect excrement. The fungi grow rapidly on this substratum and produce numerous swellings or excrescences and it is these which form the food of the ants and larvae. The formation of a new fungus garden is always undertaken by the queen, who, before departing on the nuptial flight, fills her infra-buccal cavity or pocket with active fungal hyphae. This collection is

Sugar cane growing in Pernambuco

expelled within the newly-made nest chamber and the growing hyphae are nourished, at first by the faeces of the insect, who may even sacrifice some of her own eggs for this purpose.

All the usual castes are found among the *Atta* ants, males, females, workers and soldiers, together with aberrant or pathological types, including dwarf forms, giant males, aberrant females and the peculiar egg-laying workers.

They cause incalculable damage in all tropical and sub-tropical American countries, both to crops such as citrus, coffee, cocoa, cassava, beans and yams, as well as to live forest and ornamental garden plants. In the forest young trees may be defoliated by them year after year until eventually they die. A large nest may measure up to 800 to 1,000 sq. ft. surface area, with as many as 1,000 chambers below ground, and it is true to say that it is virtually impossible to develop any serious crop agriculture where these pests abound.

Ant control

Many methods are used to control 'Sauva.' Petrol is sometimes poured into the nest and set alight. This is not very effective and is highly dangerous and expensive. Preparations containing cyanide may be blown in by pump. A mixture of sulphur and arsenic may be burnt on charcoal and the fumes led into the nest, while carbon bisulphide may be poured down natural and artificial holes leading to the subterranean chambers. All these methods have their disadvantages. Considerable success has been achieved by the use of methyl bromide. It is an efficient ant killer, but in its present form is not easy to administer, apart from its poisonous nature. It has recently been shown that parathion is lethal to leaf-cutting ants, exerting, as it does, both contact and fumigant action. Success has been achieved with liquid and 'smoke' formulations, except where peculiar nest construction prevents the distribution of the insecticide below ground. Parathion is probably the most effective chemical so far tried in this field and intensive experiments are continuing in Brazil. Much work still remains to be done, but the conquest of 'Sauva' is in sight and the eradication of Brazil's public enemy No. 1 will open up further vast areas of fertile country to agriculture.

Cocoa

At present the cocoa plantations in Bahia cover something like 250,000 hectares, with roughly 240,000,000 trees, mainly the varieties 'Comum,' 'Maranhao' and 'Para,' all belonging to the Amazon group and included in the species *Theobroma leiocarpa*. Reliable statistics are not easy to obtain, but, as far as can be ascertained, there are about 23,000 cocoa farmers in Bahia. Due to pests and diseases and a general lack of education in agricultural matters, which the Government and official institutes are trying hard to remedy, some 20,000 of these farmers annually produce less than 500 'arrobas,' or 7,500 kg. This is a fantastically low production. The maximum production of cocoa was reached in 1947 with 2,500,000 bags, equivalent to 150,000 metric tons, and the state produces today about 20% of world production. With adequate pest control this figure would be increased tremendously. The Instituto de Cacau de Bahia maintains that the annual loss caused by insects varies between 25 and 50%, and that statement tells its own story.

Healthy cotton in Sao Paulo

Pests and diseases of cocoa

Cocoa in Bahia seems to be attacked by a host of pests, though all are not important. *Atta cephalotes* and *Acromyrmex* species are typical leaf-cutting ants and require no further comment. *Azteca paraensis v. bondari*, a tree ant, is, however, the worst cocoa pest and forest insect in Bahia. It lives in symbiotic association with the epiphytic plants (*Codonanthe farmicarum* (Gesneracea) and *Epidendrum immatophyllum* and *Coryanthes maculata* (Orchidacae), as well as nursing and protecting *Pseudococcus citri* and other undetermined scale insects. This ant invariably incorporates the epiphyte in its nest and gnaws the pods and shoots of the cocoa to obtain material for nest construction. The epiphytes prevent the cocoa flowers from opening and also interfere with the physiological functions of the tree, while *Pseudococcus citri* weakens the tree by continuous sap-sucking. It is apparent, therefore, that this complex of ant, epiphyte and sap-sucker, is a serious problem to the cocoa planter.

During the years 1944-46 the Cocoa Institute sponsored a campaign to control it by cutting off the affected limbs of the trees. No fewer than 10,000,000 nests were destroyed in this manner, but, in the opinion of the writer, as much damage was caused by this drastic treatment as by the ants themselves.

The 'cacarema ant' (*Azteca chartifex*) is almost as important and is widespread throughout cocoa plantations. It lives in symbiotic association with aphids, scales and mealy bugs and appears to exist entirely on the honeydew secreted by these insects. It, too, gnaws and damages the pods and shoots of the tree from which it obtains the material for its nest.

The 'Pichicheca' or fire ants (*Solenopsis*) attend the mealy bug *Pseudococcus citri*. Here, again, *Solenopsis* seems to feed exclusively on honeydew. Indirectly it is a troublesome pest in the picking season, for its bite is so painful that operators frequently refuse to pick fruit from a tree inhabited by it. *Crematogaster magnifica*, or the acrobat ant, is a similar pest, nursing scales and mealy bugs and damaging the wood and pods by gnawing.

With all these arboreal species not only are affected trees seriously weakened, but more than 10% die every year.

The destruction of the epiphytes without damaging the tree is, at the moment, an unsolved problem, but recent evidence indicates that the tree ants might prove controllable by spray applications of parathion at concentrations varying between 0.01 and 0.05% active ingredient.

Fungi also take their toll of cocoa, the most virulent organism being *Phytophthora palmivora* (brown pod rot). This pathogen

Tobacco seedlings growing under artificial shade, Bahia

causes an annual crop loss in excess of 10%. Control measures include thinning of the overhead shade, drainage of the swamplands and spraying with a 1% Bordeaux mixture. This treatment does not seem very effective. Cuprous oxide formulations might give better control and experiments are in progress to this end.

Coconuts

There are very extensive coconut plantings in the north of Brazil. In 1940 Pernambuco produced 22,333,000 nuts, and in 1948 this had risen to nearly 30,000,000 (equivalent to 120,000 tons of copra).

Insect pests

The beetle *Rhynchophorus palmarum* does considerable damage both in the larval and adult stages, devouring the upper parts of the palm and boring into the succulent portions of the leaf stems and central shoots. More important than this direct damage, however, is its transmission of the nematode *Aphelenchoides cocophilus*, which causes ' Red Ring Disease,' a most serious infection responsible for the death of many thousands of trees each year.

' Red Ring Disease ' is known, of course, in Trinidad, British Honduras, Panama, Venezuela and Costa Rica, but it has only recently been shown that the nematode is frequently transmitted to healthy trees by *Rhynchophorus*. Many thousands of larvae have been dissected, and in every case *Aphelenchoides* was found swarming in the intestinal tract. Not only is the eelworm introduced into the green plant tissues by the direct feeding of the larvae, but it is expelled with the faecal pellets which fall to the ground, the nematode then gaining entry to the tree via the root system. Infected trees die within four years or so.

The external symptoms include excessive wilting and drooping of the foliage at the apex, and, as time passes, the lower green stems lose their natural turgidity and droop, eventually dying back altogether. If the tree is sectioned, a broad, reddish-brown ring is evident, cutting the medullary rays at right angles and extending to a complete circle. Frequently the entire length of the trunk is affected.

At present there is no effective control against *Rhynchophorus*, although DD (dichloropropane-dichloropropene) has been found an efficient nematocide against those eelworms living free in the soil. If the only mode of entry of *Aphelenchoides* were via the roots, DD would be an economic measure, but it is of little use whilst its beetle host can transmit infection from above. BHC and DDT are useless against it and nicotine sulphate has but little effect. Slight control appears to be exercised by parathion as a liquid spray and arsenic as a dust, but research is required in order to find a solution to this grave problem.

The beetle

Rhina barbirostris is another pest of importance to the Brazilian coconut industry. Unlike *Rhynchophorus*, it attacks the more mature parts of older trees. Eggs are laid in excavations in the bark and the larva, which lives for four or five months, burrows directly into the wood of the trunk. Its galleries cut the main circulatory vessels; as many as 5,000 holes have been found in one tree.

Some of the smaller farmers light fires at the base of each coconut tree to hasten fruiting. In consequence, the bark for about 5 ft. from ground level is charred; *Rhina barbirostris* is particularly fond of selecting such sites for oviposition.

Due to the habits of the larvae, the application of insecticides to them is impracticable, while the adults collect in the topmost, densest parts of the palm. The usual remedy employed by the average farmer is to poke a wire into a borehole, thus crushing the larva inside. As after two months or so the larvae stop up the entrances to the holes with sawdust, many are missed in the upper portions of the trunk.

Cotton

Cotton has, in recent years, been coffee's closest competitor as Brazil's most valuable crop. The cotton plant is indigenous to Brazil and, although grown in practically every state, Sao Paulo leads in production.

The foundations of the industry in Sao Paulo were laid during the 1920s through the work of the State Agricultural Institute at Campinas in developing suitable seed and improving ginning. The output continued the general upward trend from 1930 to 1944, when a record crop of 586,098 metric tons (2,700,000 bales) was attained. During these years the climatic conditions were good. Since 1944, however, weather conditions have been less favourable, no doubt due to the eradication of forest, and yields have declined. Other circumstances which have brought about a reduction in crop are losses from insects and fungi and scarcity of labour.

Insect pests of cotton

The most important insects attacking cotton include *Gasterocercodes brasiliensis*, *Aphis gossypii*, *Horcius nobilellus*, *Platyhedra gossypiella* and *Alabama argillacea*.

The beetle *Gasterocercodes brasiliensis* is a major pest of young cotton (the fully-grown plant is generally resistant) and is found on a great number of intermediate hosts. It invades cotton areas from the surrounding vegetation and attacks when the young seedlings are about 8 or 10 cm. high. The adult attacks the stem near ground level and lays its eggs in the damaged portions. The resulting larvae bore into the stem and the root system. Attacked plants wilt and usually die.

Aphis gossypii also exists on many other host plants. It propagates extremely rapidly and, especially in dry years, is a pest of considerable importance.

The flea hopper *Horcius nobilellus* and its allies, *Colocris stigmosus*, *Garganus gracillentus* and *Creontiades rubrinervus*, are also important pests. This complex, both in the adult and larval stages, sucks the sap of the plants, causing shedding of ' squares,' young bolls and the dropping of flowers. The physiological reaction of the plant is a noticeable increase in growth and invaded cotton is invariably tall and spindly. Attack generally starts in December and it is at

this time that control measures should be instituted to avoid a heavier build-up in February and March. If no control measures are taken at the time recommended, the damage to cotton is tremendous and may amount to 50% of the crop.

The pink bollworm (*Platyhedra gossypiella*) varies in importance from year to year, but in bad years builds up to alarming proportions notwithstanding the routine fumigation of the seed with methyl bromide.

The cotton leaf worm (*Alabama argillacea*) does not over-winter in Sao Paulo State and its activities vary greatly from year to year. When a large invasion takes place great damage is done, usually in January, February and March. In some years it does nearly as much damage as the flea hopper.

The advent of BHC and DDT has wrought a considerable change and adequate control can now be achieved with a combined BHC, DDT and sulphur dust in the proportion of 3 : 5 : 40. Gamma-BHC sprays (dispersible powders) have also been successfully used; recently good control has been achieved against *A. argillacea* and red spider with parathion formulations.

Sugar

There are more than 1,000,000 acres of sugar cane in Brazil, but yields are relatively low (between 40 and 42 tons of cane to the hectare). Brazil has a large home consumption of sugar to satisfy and exports little. The total production ceiling for sugar has been set at 23,000,000 sacks, but very much more could be produced by raising the average production per unit area through better farming and pest control.

Insect pests

An insect of considerable importance is the mealy bug *Margarodes carvalhoi*, which lives on the subterranean root system of the cane. The saliva of this species is highly toxic to plant tissues and causes severe necrosis of the roots, known in Pernambuco as ' Sugar Foot Rot.' Heavy losses are caused by it and an efficient and cheap control is eagerly awaited. Dichloropropane-dichloropropene (DD) is effective, but is too expensive.

The stem borer

Diatraea saccharalis is, at the moment, not a serious problem in Pernambuco, although it is a major factor in the adjacent state of Sergipe and in the south. Probably Pernambuco will eventually be invaded on a large scale, but at present it appears to be adequately checked by the biological control exercised by *Trichogramma Minutum*, *Paratheresia claripalpis* and *Microbracon spp*. It is worth noting, however, that the use of BHC, DDT and 2, 4-D (for weed control) elsewhere has, on occasion, increased the build-up of *Diatraea* by exterminating its parasites, and this should be borne in mind when contemplating their large-scale use on sugar cane.

Clean bananas after spraying with cuprous oxide fungicide, Santos, Sao Paulo

Ligyrus bituberculatus and *humilis* (coleoptera) attack sugar cane after planting, damaging the stem. In the case of *bituberculatus* the larval stage is the most important, whereas with *humilis* the adult causes the major damage. Normally they only attack underground, but sometimes the adults of *bituberculatus* gnaw the stem above soil level. Besides the direct damage, the borings allow the entry of fungal pathogens and many ' setts ' are destroyed where these beetles are prevalent.

The usual control measures include trapping the flying adults by a powerful light and injecting the soil with carbon bisulphide. Neither of them seems particularly successful, but extensive trials are in progress in the northern states using gamma-BHC as a soil insecticide at rates equivalent to 40 to 60 kg. per hectare of material containing 0.45% gamma isomer.

The froghoppers (*Tomaspis, Mahanarva*) are little in evidence in Pernambuco, but are a major menace in the south. Despite a 10% loss of crop, little action appears to be taken. *Tomaspis liturata* is rather difficult to attack, as it remains for long periods under the protective cover formed where the leaf ensheaths the stem. No doubt control of this complex could be obtained by a gamma-BHC dust on a very fine filler.

Tobacco

Tobacco is widely grown in Brazil and, although it is attacked by a host of insect pests, only a few are really important. *Epitrix parvula* is well controlled by the use of a 50% DDT wettable powder, whilst *Protoparce sexta* is highly susceptible to BHC and parathion in its early larval life. The cutworms *Plusia nu* and *Feltia annexa* are a problem, but the indications are that BHC used as a bait, placed around or near the plants, will prove a useful measure. A serious menace is the springtail *Isotoma palustris*, which punctures the leaves on each side of the midrib. It is obvious that the saliva of this insect is toxic; judging from results elsewhere, parathion would seem to be indicated here.

Tobacco's most serious enemy is the eelworm *Heterodera marioni*. This group devastate many Brazilian crops and cause heavy loss. No remedy is known except DD, which is too expensive.

Most of the tobacco crops in Brazil are badly infected with tobacco mosaic virus. At a certain stage of growth the growing shoot is nipped off between the fingers and a couple of operators can transmit the virus to a whole field in a remarkably short time. A large proportion of the cigarettes smoked in Brazil carry the active virus and workers who smoke in the plantations are largely responsible for transmission, the virus being transferred from the cigarette to the fingers, and from thence to the plant on which they happen to be working.

Bananas

Notwithstanding that many thousands of hectares are planted with bananas in Brazil, pests are not a great problem. Undetermined lepidopterous larvae occasionally defoliate a plant, but this is not common. Perhaps the main problem is a fungal one, for *Cercospora musae* certainly seems to be spreading throughout the banana region of Sao Paulo and Rio de Janeiro and the

(*Concluded on page* 364)

The Effect of Surface Cultivation on Soil Structure and Crop Growth

The Use of Herbicides in Studying the Problem

C. L. W. SWANSON and H. C. M. JACOBSON

Connecticut Agricultural Experiment Station

It has long been accepted that the main value of intertillage in growing crops is the eradication of weeds which compete with the crop for moisture and plant food, the older view that tillage itself improved soil conditions having been largely superseded. This has recently been challenged by Messrs. Swanson and Jacobson who, as a result of experiments carried out at the Connecticut Agricultural Experiment Station using 2—4 D for weed control, claim to have established that on certain types of soil and under certain weather conditions, surface tillage may profoundly affect the physical and biological conditions in the surface soil and influence crop growth. This account of their work will be of interest to all concerned with tillage problems.

WITH the advent of herbicides a new tool has been made available for studying the effect of soil physical properties on crop growth, which may be used for solving such problems as 'What are the beneficial effects, if any, accruing from cultivation for the control of weeds?' and 'Is cultivation necessary for maximum production?'

The literature is replete with records of experiments which have led to the conclusion that the main reason for cultivation is to control weeds.[4, 5, 7, 12, 13, 17, 18, 19] Many of the textbooks on soils and crops state that the value of cultivation is mainly the control of weeds.[2, 10, 11, 16, 23] It is claimed that by controlling weeds by cultivation competition for soil moisture and plant nutrients is reduced. Weeds, it is pointed out, transpire large amounts of moisture and immobilise considerable plant food and these losses are eliminated when weeds are destroyed.

Early work on cultivation

Much of the work on the value of cultivation was done in earlier days, and after the general conclusion has been reached that the chief value of tillage is as a weed-control measure little has been done on the subject in recent years. In these early experiments the plots were usually kept weed-free by scraping or quick chopping of the weeds. Thus Mosier and Gustafson[13] describe the method of control used on a weed-free plot as 'scraping with a sharp hoe so as to produce practically no mulch.' The same method was used by Cates and Cox.[5] They state that particular care was to be paid not to stir the soil any more than absolutely necessary. They believed that the principal value of cultivation lies in the killing of weeds and not in the aeration of the soil or the conservation of moisture. They based their conclusions on 125 cultivation experiments conducted in 28 states from 1905 to 1911 in which regular cultivation was compared with scraping with a hoe to destroy weeds. The scraped plots produced on an average 99.1% as much corn as did the cultivated plots.

Soil factors and plant growth

Chief among the soil factors affecting plant growth is the nature of the soil itself, including its physical and chemical properties. A great deal of attention has been given to the chemical or fertility status of the soil, but less to its physical nature until comparatively recently.

Most of the experiments with herbicides have been concerned with their effect on weeds and the crop in question, but little attention has been given to the manner in which soil factors may affect production when herbicides are used, although several workers have investigated the effects of herbicides on the microbiological population of the soil.[15]

With herbicides like 2,4-D weeds can now be controlled, at least initially, without disturbing the soil surface, and the effect of non-disturbance of the soil surface can now be compared with disturbance due to cultivation. This allows study of the effect of the physical properties of soil, especially that of the soil surface, on crop growth. Two years' results using this method of approach for comparing cultivation versus no cultivation for weed control are now available.

Experimental details

In order to test the hypothesis that cultivation may be beneficial in ways other than by controlling weeds, corn plots were set up on Cheshire loam soil at the Station's Mount Carmel Farm in 1948. Characteristics of this brown podzolic soil are published elsewhere.[9] The following treatments were laid out: (a) pre-emergence control of weeds in corn with 2,4-D and post-emergence spray 45 days later (non-cultivated); (b) control of weeds in corn by flaming plus cultivation (flamed three times and cultivated once same time as last cultivation of cultivated plots); and (c) control of weeds in corn by ordinary cultivation methods.

All of the plots received equivalent amounts of fertilisers. Corn was used because it is an excellent indicator of plant nutrient deficiencies, especially nitrogen, phosphorus and potassium.

Weather conditions, herbicides and soil compaction

In growing crops in the field unusual weather conditions sometimes have more effect on the crop than does the cultural treatment. The years 1948 and 1949 afforded an excellent opportunity for studying the effects of cultivation versus no cultivation on crop growth. During those years unusually heavy rains fell,

packing the ground. Later in the season it became unusually hot and dry, baking the soil and forming a hard crust on the surface.

The effect of this soil crust was measurable not only in decreased corn yield, but also in soil property changes. In 1948 differences in growth did not show up until the corn was about a foot high. In the 2,4-D plots the corn was smaller, lighter green and less vigorous than that on the cultivated plot.[22] The differences showing up were due to the hard surface crust. Evidently this crust did not allow free circulation of air into the soil, setting up reducing conditions, and resulted in a decrease in the production of nitrates by soil organisms. The plot was practically weed-free, so no competition existed for moisture and plant nutrients. There were no observable 2,4-D injuries. Height measurements of the corn 50 days after planting gives an index of its later growth. The 2,4-D treated corn averaged about 3½ in. shorter than the cultivated corn.

Comparison of the corn yields with the physical nature of the soil shows the importance of good soil structure on crop growth. For the surface 2 in. the arithmetical difference in amount of large pores between the cultivated as against the 2,4-D plots was 3.4% more large pores (20.2% and 16.8% respectively) in the cultivated ones,[21] amounting to a 20% difference. The yields were 61.5 and 15.2 bushels respectively, or 46.3 bushels more for the cultivated corn.

Although weeds were well controlled for the first month in the 2,4-D plots, some broadleaf weeds started appearing with grass weeds, being mainly foxtail and crab grass. A second application of 2,4-D at the end of the last cultivation killed most of the broadleaf weeds, but the grasses were not affected.

As mentioned above, corn growth was more vigorous and the plants larger in size on the cultivated plots. Evidently the combined effect of corn and weeds on the moisture in the 2,4-D plots was less than in the cultivated plots.[22] This strongly suggests that weeds were not the limiting factor to plant growth; rather was it due to the poor physical condition of the soil in the 2,4-D plots.

Flamed plots

Further evidence that the physical nature of the soil affects crop growth is afforded by the flamed plots. The effect of breaking up the surface crust is reflected in the yield difference of only 8.8 bushels in comparison with the cultivated plots. The amount of large pores for the two plots is about the same, 21.1 and 20.9% respectively. Flaming kept weeds down initially, but did not kill all of them. It was estimated that after the flamed corn was cultivated about 10 to 15% of the ground was covered with grass weeds (mostly crab grass). It was noticed that after the flamed corn was cultivated it became darker green in colour, indicating greater nitrification activity in the soil. This fact, together with the yield differences in comparison with the cultivated plots, indicates the importance of loosening hardened surface soil. Moreover, the surface crust on the flamed plots appears to be responsible for the retarded growth (7 in. shorter than cultivated corn 50 days after planting).

Second year experiments

On the basis of data obtained during 1948 the plot arrangement was revised and transferred in 1949 to the Humphrey plot area of the Station Farm, which has the same soil type. Flaming of weeds was omitted and scraping with a hoe for weed control similar to that described by Cates and Cox[5] and Mosier and Gustafson[13] was added. In addition, pre-emergence control of weeds with 2,4-D + one cultivation coinciding with the last cultivation for the cultivated plots was included in the experiment. All of the plots were randomised. The 1949 studies confirmed the observations made in 1948. In many respects weather conditions were similar; a wet spring was followed by a hot dry summer, which produced soil-crusting conditions.

The following yields per acre, using farmyard manure and fertilisers (Fig. 1), were obtained: cultivated = 94.6 bushels; 2,4-D + one cultivation = 84.7 bushels; scraped = 80.3 bushels; 2,4-D only = 68.3 bushels. The yield differences were not as large as those obtained in 1948, but they followed the same pattern for similar fertiliser treatments. Thus a difference of 26.3 bushels is shown between the cultivated and 2,4-D-only treated corn. No injuries to the corn by 2,4-D were observed. Smaller yields were obtained for the plots not treated with farmyard manure, which is to be expected, but the trend of the yields is the same.

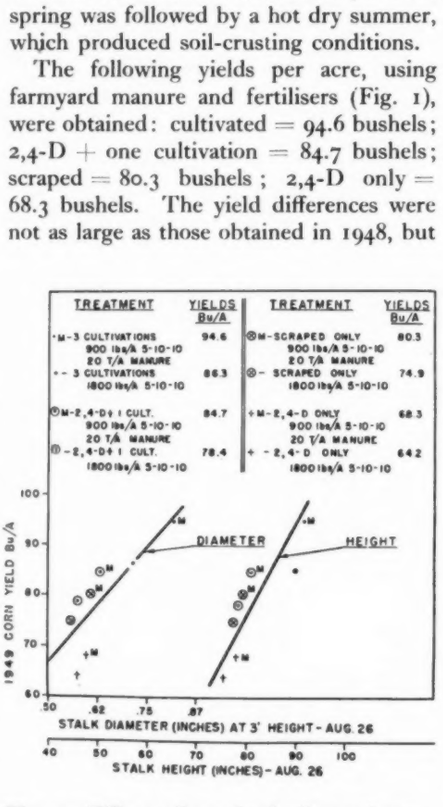

TREATMENT
YIELDS Bu/A
•M-3 CULTIVATIONS 900 lbs/A 5-10-10 20 T/A MANURE 94.6
• - 3 CULTIVATIONS 1800 lbs/A 5-10-10 86.3
⊗M-2,4-D+1 CULT. 900 lbs/A 5-10-10 20 T/A MANURE 84.7
⊗ - 2,4-D+1 CULT. 1800 lbs/A 5-10-10 78.4
⊗M-SCRAPED ONLY 900 lbs/A 5-10-10 20 T/A MANURE 80.3
⊗ - SCRAPED ONLY 1800 lbs/A 5-10-10 74.9
+M-2,4-D ONLY 900 lbs/A 5-10-10 20 T/A MANURE 68.3
+ - 2,4-D ONLY 1800 lbs/A 5-10-10 64.2
DIAMETER
HEIGHT
1949 CORN YIELD Bu/A
STALK DIAMETER (INCHES) AT 3' HEIGHT - AUG. 26
STALK HEIGHT (INCHES) - AUG. 26

Fig. 1—Effect of method of weed control on the yield and growth of corn grown on a Cheshire loam soil

Macroporosity differences in the surface 2 in. of soil (cultivated, 19.75%; 2,4-D, 17.76%) on the plots above were not as large as in 1948. This is in line with the corn yield difference, there being 46.3 bushels in 1948 and 26.3 bushels larger yield in 1949 for the cultivated plots. Heights of stalk (91.9 and 78.4 in. respectively) and diameter of stalk at 3 ft. height (0.82 and 0.60 in. respectively) taken on August 26 (Fig. 1) compare favourably with the physical status of the soils in these plots.

In obtaining soil cores for porosity determinations, a record was kept of the amount of force (Fig. 2) required to drive the core sampler into the soil.[20] To penetrate the surface 2 in. of the 2,4-D plots an average of 10.25 strokes of a 12-lb. hammer falling 2 ft. were required in comparison with 5.75 strokes for the cultivated plots. Thus 78% more force was required to break through the soil in the 2,4-D plots than in the cultivated ones. Fig 2. shows that the greatest penetration differences were obtained in the 0-2 in. depth.

Scraped plots

It is difficult to make comparisons on the basis of regarding the scraped plots as having undisturbed soil, since it is practically impossible to use a hoe for cutting off

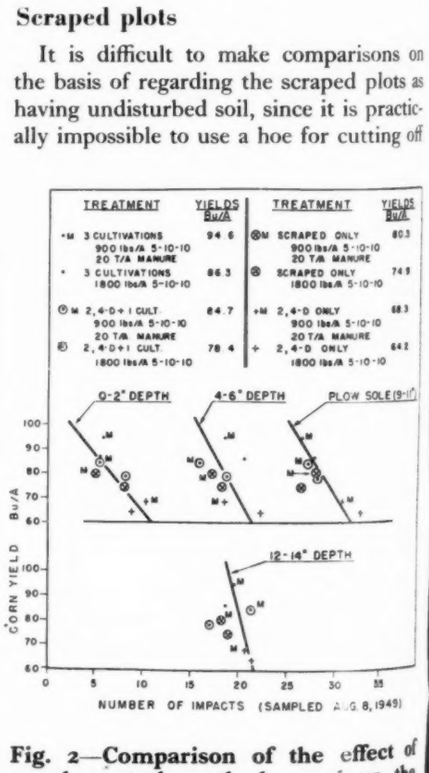

TREATMENT
YIELDS Bu/A
•M 3 CULTIVATIONS 900 lbs/A 5-10-10 20 T/A MANURE 94 6
• 3 CULTIVATIONS 1800 lbs/A 5-10-10 86.3
⊗M 2,4-D+1 CULT. 900 lbs/A 5-10-10 20 T/A MANURE 84.7
⊗ 2,4-D+1 CULT. 1800 lbs/A 5-10-10 78 4
⊗M SCRAPED ONLY 900 lbs/A 5-10-10 20 T/A MANURE 80.3
⊗ SCRAPED ONLY 1800 lbs/A 5-10-10 74.9
+M 2,4-D ONLY 900 lbs/A 5-10-10 20 T/A MANURE 68.3
+ 2,4-D ONLY 1800 lbs/A 5-10-10 64.2
0-2" DEPTH
4-6" DEPTH
PLOW SOLE (9-10")
12-14" DEPTH
CORN YIELD Bu/A
NUMBER OF IMPACTS (SAMPLED AUG. 8, 1949)

Fig. 2—Comparison of the effect of weed control methods used on the compaction of soil at various depths and on corn yield

The experimental plots were on Cheshire loam soil. Note the difference in the corn growing on the cultivated plot (*left*) and that on the non-cultivated plot (*right*)

the weeds at ground level without disturbing the soil surface. For this reason the writers do not consider these plots as having had an undisturbed soil surface throughout the growing season as contrasted with the 2,4-D plots. The effect of disturbing the soil surface is seen in a comparison of the yields for the scraped and the 2,4-D + one cultivation (80.3 and 84.7 bushels respectively). Further evidence of disturbance is shown in the 18.44% surface macroporosity as compared with the cultivated and 2, 4-D plots mentioned above. Increased height (79.6 in.) and diameter (0.61 in.) of stalk as compared with the 2,4-D plots show the effect on disturbing the surface of the soil (Fig. 1).

Nitrogen tests

In 1949 nitrate nitrogen tissue tests were made on August 30 of the corn stalk 4 to 6 in. from the ground surface. Arbitrary values of 0 for ' no nitrate ' and 12 for ' high test nitrates ' were set up. On this basis the reading for the plots receiving only inorganic fertilisers (Fig. 3) for the cultivated, 2,4-D + cultivation, scraping, and 2,4-D only plots were 9.4, 7.3, 6.1 and 6.9 respectively. Plots receiving the same cultural treatments, but with farmyard manure in addition to the fertiliser, gave readings of 11.0, 6.3, 6.4 and 4.4 respectively. These readings are in line with the other data reported above, reflecting the effect of the poor physical nature of soils on plant growth.

Nitrate nitrogen studies were made of the plough depth layer of soil (0 to 8 in.) at intervals throughout the growing season (Fig. 3). It is interesting that immediately after cultivating the 2,4-D + cultivation plots the nitrate nitrogen content went up from 87.9 to 101.4 lb. per acre (July 7 and July 27) respectively. This strongly suggests that the surface crust was broken, thereby permitting free movement of air in the soil and making conditions more favourable for nitrification. These data (Fig. 3) are for the unmanured plots. Since manure acts also as a soil conditioner, differences in nitrate production were less, being 76.5 and 81.1 respectively. In contrast, the cultivated plots decreased from 90.9 to 70.0 lb. per acre for these same dates. The trend for the cultivated plots was from a high to a low amount of nitrates as the season progressed. This suggests that the cultivated corn plants which were growing vigorously (Fig. 1) were utilising the nitrates about as quickly as they became available. On the other hand, the plants in the 2,4-D + cultivation plots were not able to take up the nitrogen as quickly and it was not until later that the plants grew vigorously enough to utilise the available nitrates. For example, on the next sampling (August 8) the nitrate nitrogen content had decreased to 73.4 lb. per acre, while that of the cultivated plots was 50.4 lb. per acre. In the case of the 2,4-D only plots, in the early part of the growing season soil crusts had not formed and nitrate production was about equivalent to that of the other plots (Fig. 3). Then later in the season, with hotter and drier weather and soil crusting, less nitrates were produced, thereby retarding corn growth (Figs. 1 and 3). Observations throughout the growing season confirm this.

Discussion

It appears from a review of the early literature that a serious error was made in the research techniques used for studying the effect of weeds on crop production. The early researchers failed to take into account the effect of surface soil compaction on plant growth. The surface inch or two of the soil was disturbed in scraping off the weeds. In the experience of the authors, it is practically impossible to cut off weeds with a sharp hoe without cutting into the soil. The weeds have to be cut off flush with the soil surface to kill them, and this operation breaks open the soil surface. In fact, what actually happens is that the soil is skimmed, which tends to leave a fine soil mulch on the surface. Under these conditions air can easily enter the soil and reducing conditions cannot exist.

With the advent of herbicides weeds can be controlled without disturbing the soil. This offers a new tool for studying the effect of the physical nature of soils on crop production. In particular, the effect of cultivation on crop response can now be more accurately measured.

The data presented for two seasons are not conclusive proof that cultivation is always desirable. It is believed that the usefulness of cultivation will vary with weather conditions and with soil types. In some seasons it may not be necessary to cultivate. Such a season would be one with rain of low intensity occurring rather frequently, supplying adequate moisture for maximum crop production. Thus the soil surface would not be compacted and air could move easily in or out of the soil. In seasons having rains of high intensity, which result in packing of the soil, and especially if this is followed by a hot dry period, cultivation would be essential for maximum crop production. The crust formed on the soil surface will need to be broken if reducing soil conditions are to be avoided. On the lighter soils of a sandy texture it is conceivable that the coarse nature of the soil will prevent soil crusting and no benefits from cultivation will accrue. In the heavier soils hard rains will pack the soil, washing the silt and clay fractions into the soil pores, stopping the movement of air, especially at the soil-air interface.

The pore space of the soil is filled with varying proportions of air and water reciprocally related to each other. When the pores are filled with water the air is completely displaced. When the pores in the surface soil-air interface are clogged the supply of oxygen to higher plants and soil micro-organisms is greatly diminished. Soil crusting is an example of clogged

pores; when this occurs silt and clay fractions have been washed into the pores by rain water, forming a baked surface on exposure to a hot, drying sun. Unless the crust is broken by cultivation, anaerobic conditions will prevail, for air can enter the soil only slowly. Little oxygen will be brought into the soil by rain water for the solubility of oxygen in water is small (0.04 c.c./ml.). The rate of movement of oxygen through soil pores filled with water is too slow to meet the demands of a normal soil flora. Under such anaerobic conditions the soil-reducing conditions will be produced if a sufficient amount of readily oxidisable organic matter is present and if the soil temperature is favourable for microbiological activity. Under such conditions some soil constituents will become toxic to plants, being changed from the oxidised to the reduced state[3] as follows:

Element	*In oxidised soil*	*In reduced soil*
Carbon	CO_2	CH_4, aldehydes, etc.
Nitrogen	NO_3	NO_2, NH_4+, N_2
Sulphur	$SO_4=$	$SO_3=$, $S=$
Iron	Fe^3+	Fe^2+
Manganese	Mn^4+	Mn^3+, Mn^2+

Moreover, in a reduced soil ample supplies of nitrates will not be available for maximum growth, and nitrogen deficiencies in the plant will show up. Ammoniacal nitrogen can be utilised by some plants, but not as quickly nor in so large quantities as nitrates.

In the plots reported on weeds were not eliminated altogether in the 2,4-D plots. The plots were weed-free for the first month and then grass (foxtail and crab grass) started coming in. Later post-emergence applications of 2,4-D practically eliminated the broadleaved variety of weeds. Weed competition, then, was controlled initially and reduced to about 60 to 75% control in the latter part of the season. Techniques are now being worked out to get 100% weed control throughout the season without cultivation.

The results obtained in 1949 for the 2,4-D + one cultivation plots indicate that a combination of herbicides plus cultivation would give maximum crop production, at least for seasons of high-intensity rains which pack the soil surface. In seasons of low-intensity and abundant rainfall cultivation might be dispensed with on the lighter soils, and a combination of herbicides used for controlling weeds. This might be a pre-emergence herbicide like 2,4-D to control the weeds for the first month, then using a post-emergence spray of 2,4-D to kill the broadleaved weed varieties and some other herbicide to control the grasses. At present, however, an effective herbicide for killing grasses in cultivated crops like corn is not available.

It is quite likely that one explanation for the diversity of results[1, 6, 14, 21] obtained where 2,4-D was applied and not cultivated, in contrast to 2,4-D + cultivation, can be attributed to soil factors. It seems possible that, in many instances, 2, 4-D has been blamed for lower yields which correctly should be attributed to soil factors.

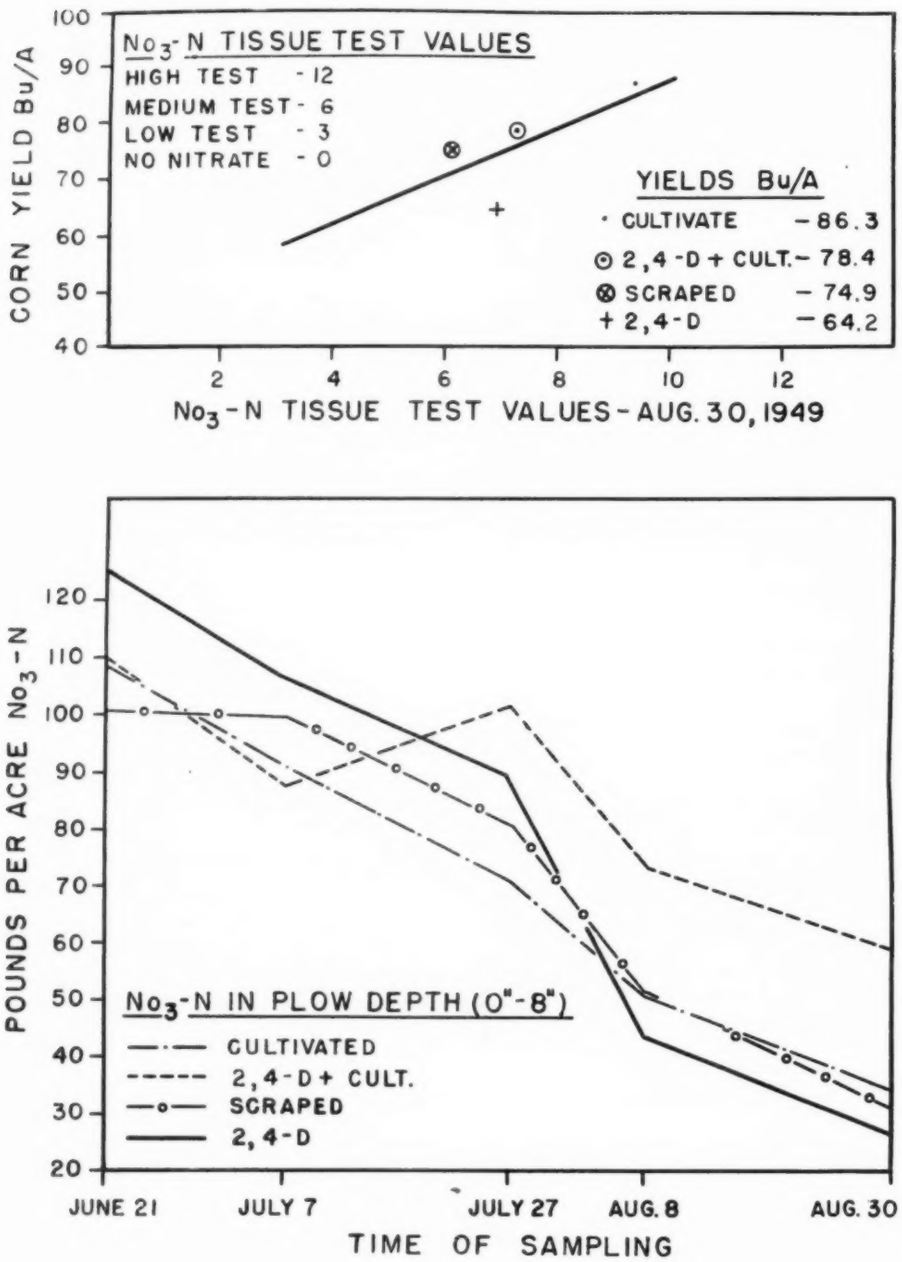


Fig. 3—Nitrate nitrogen tissue test values compared with corn yields and method of weed control (*upper graph*). The effect of soil disturbance and non-disturbance as produced by various methods of weed control on nitrate nitrogen content in the soil (*lower graph*)

Contribution from the Department of Soils, the Connecticut Agricultural Experiment Station, New Haven, Conn.

For a list of the literature cited in this article see p. 368.

Photos and graphs: Dept. of Soils, Connecticut Agricultural Experiment Station.

Mechanisation of Tropical Agriculture

Demonstration at the Imperial College of Tropical Agriculture, Trinidad

Field demonstrations of various aspects of mechanised agriculture are almost an everyday occurrence in the more developed parts of Europe and America. The extension of mechanisation to agricultural operations in tropical countries is, however, coming more and more to the fore, as the following account shows.

WE need hardly remind our readers that this College, which recently celebrated the Silver Jubilee of its foundation, is playing an increasingly important part in research and teaching in the British tropics, and serves as a training institution for officers of the British Colonial Agricultural service.

One of the many lines of work receiving attention at the College is the mechanisation of field and plantation operations. The emphasis is being placed on the use of small and medium-sized units which should be within the reach of most estate owners, and some small proprietors. Practical evidence of the mutual interest of the I.C.T.A. and the manufacturers of agricultural machinery in bringing the possibilities of mechanised farming to the notice of college students and visitors to College Farm was demonstrated in May when the Agricultural Society of Trinidad and Tobago visited the farm.

During the morning a number of demonstrations were given by the College and in the afternoon the facilities of the farm were made available to manufacturers' agents, who were able to demonstrate a wide range of equipment, both stationary and at work, in the field.

In his opening remarks Professor C. Y. Shephard, Acting Principal, stressed the way in which mechanisation could, and should provide agriculture with labour-serving devices rather than those which are purely labour-saving. Unemployment is not necessarily a result of mechanisation, which, properly applied, can be a means of raising the general level of agriculture and the standard of living. Professor C. W. Lynn described the policy of the College Farm and its role in the teaching and experiment programmes of the College. A wide range of agricultural conditions had of necessity to be covered during the practical training of students, and for this reason the farm would develop as a mixed unit providing opportunities for instruction in tillage, livestock and grassland management and some plantation crops. Instruction on the farm was supplemented by regular visits to many of the excellent estates throughout the island where plantation crops could be seen under good management.

Most of the machinery was shown and operated by the Port of Spain Agencies of the major British agricultural machinery manufacturers. The College demonstrated a number of ploughs ranging from the simple Ransome 'Mysore' pulled by two Zebu oxen to the Ford-Ransome and Ferguson mounted mouldboard and disc ploughs; and the visitors were able to see recent progress in the mechanisation of cultivations for the planting of yams.

During the afternoon Mr. C. R. Massy, of Neal and Massy Engineering Co. Ltd., Port of Spain, formally presented to Professor C. Y. Shepherd Ferguson tractor equipment which had been made available to improve the facilities at the College for teaching, demonstration and experimental work.

Additions to the equipment of the farm have similarly been made by the International Harvester Company, Associated British Oil Engines Ltd., and International Crushing and Grinding Equipment Ltd. Amongst the small tractors are a 7 h.p. two-wheel unit, the 'Trusty,' successfully used for shallow ploughing and cultiva-

A seedbed 10 in. deep was formed in one operation by the 'Rotavator' attached to the Fordson 'County' tracklayer with a diesel engine. (*Below*) **The ploughing performance of the Ransomes MG5 has been shown at the I.C.T.A. to be roughly equivalent to that of four oxen. Here it is seen ploughing grassland during the morning demonstrations.** (*Below*) **An autoscythe is not usually asked to tackle a job like this, but the Allen 'Oxford' was demonstrated in young elephant grass.** (*Bottom*) **A Fordson 'Major' makes light work of three furrows during the afternoon demonstration**

tions, and the 7 h.p. crawler, Ransome MG5, which has been shown to exert the same pull as four large oxen. These units were also made available by the generosity of their makers.

This was the first occasion on which agriculturists of the Colony have had the opportunity of seeing a considerable number of agricultural machines on display at one time. The success of this field day was mainly due to the co-operation of the machinery dealers, and to the arrangements made by Mr. J. E. Mayne, Senior Lecturer in Agriculture, Mr. J. S. Campbell, Farm Manager, and Mr. F. Hudson, Assistant Farm Manager.

Photos: Imperial College of Tropical Agriculture, Trinidad.

The Fordson 'Majors' were well presented at Trinidad by Charles McEnearney & Co., Ltd., who also showed a new Ford 'Consul' saloon

More Tractors in Cyprus

The use of Western type farm machinery in Cyprus continues to increase.

Last year 75 tractors were imported—more than one a week—of which 28 were heavy Diesel models.

The majority came from the United Kingdom, although Germany is assuming some importance as an exporter of tractors to Cyprus.

Revealing these facts in his annual report, Mr. P. C. Chambers, Director of Agriculture, says that more than 450 tractors are now in use in Cyprus, compared with 27 in 1938.

Steel Supplies: Preference Treatment Introduced

The Ministry of Agriculture has announced that a scheme for according preferential treatment to orders for general steel is now in operation for agricultural machinery manufacturers in the U.K. The scheme is intended only to apply to bottlenecks or cases of exceptional difficulty where production is being held up for supplies of a particular item. The total tonnage of general steel represented by orders is very small, the Ministry emphasises, but in appropriate cases it is prepared to issue a preference treatment (P.T.) certificate, which the manufacturer will present to his steel supplier.

The P.T. scheme is quite independent of the allocation scheme for general steel, which is to be introduced, states the Ministry, as soon as possible.

Applications by manufacturers for P.T. certificates should be made to the Ministry's Machinery Production Branch, 14-21 Chester Terrace, Regent's Park, London, N.W.1. Manufacturers of farm tractors should apply to the Ministry of Supply.

The 'Robot' unit transplanter, latest addition to the range of implements approved by Ford Motor Co.

Hydraulic Remote-Control

A new remote-control system which enables the farmer to raise, lower, or adjust trailing-type implements without leaving the tractor seat is described in a catalogue just released by International Harvester Co.

A touch on a small lever located within reach of the operator gives control over trailed equipment without stopping the tractor when using this new hydraulic control unit. Hard-to-reach control ropes are eliminated by this device, which is designed for use with McCormick International Standard, Orchard, and Grove Tractors and International Crawler Tractor models T-6, TD-6, T-9, and TD-9.

New Sack Renovating Factory

The biggest factory in the United Kingdom for the reclamation of used jute and hessian sacks was recently opened at Newport, Mon., by the firm of William Palfrey (Jute) Ltd., whose associated firm are the manufacturers of 'Palfsacks' multi-ply paper sacks. The factory is laid out specially for the processing of used sacks so that they can be given a further lease of life. Between each usage they are cleaned in powerful suction machines and huge brushes which extract all dust and deposit.

With the general world shortage of new jute goods this factory should contribute towards answering the present demand for sacks.

Further Notes on Kenaf

A. E. HAARER, F.L.S.

With growing jute shortages, increasing interest is becoming attached to alternative fibres which can be used as jute substitutes. Kenaf, a species of Hibiscus, is one of the most important, and much work has been done on it in U.S.A. and Cuba. Notes on the crop have already appeared in WORLD CROPS *and this article supplements previous information.*

A GOOD deal of attention has lately been directed to the crop known as Kenaf, particularly in the Western Hemisphere, where attempts have been made to develop its cultivation as a substitute for jute. The most important developments have been carried out in Cuba, and in a previous issue of WORLD CROPS[1, 2] notes have appeared concerning it. In other countries also it has attracted attention and some attempts have been made to encourage its cultivation in the Union of South Africa,[3] where it is known as Wildestrokroos, while some work has also been done on the crop in Russia.

It may be surprising to some to learn that Kenaf fibre is nothing more than the Bimlipatam, or Bimli-jute, which has long been exported from Madras, where at least two mills have been engaged in spinning the fibre since 1910.[4, 5] And yet there is a difference, because Kenaf as grown by modern mechanised methods in the Western Hemisphere promises a uniformity of strength and character which Bimli-jute can never possess so long as it is grown and retted by a multitude of peasant farmers in India. It is because of this lack of uniformity that reports on Bimli-jute have varied so greatly and caused it to be damned as inferior to the better classes of true jute. Moreover, its lack of flexibility, no matter how the fibre is cultivated and extracted, involves altering spinning yarn techniques and precludes fibre being used for the finer counts of yarn and for the production of finer textiles. So great, however, is the urge to break the monopoly held by India and Pakistan in jute fibre, and to develop independent supplies in safer areas for strategic reasons, that means are being sought to overcome this drawback.

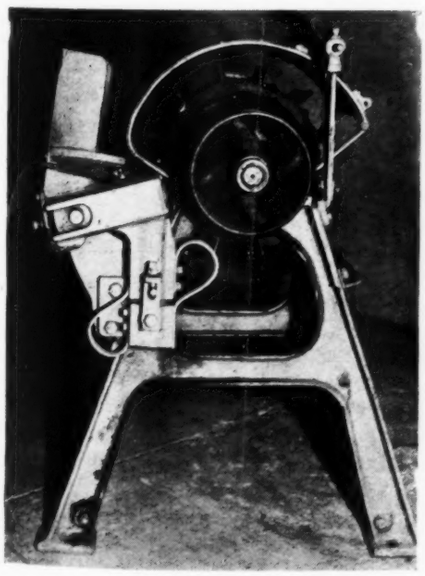
Kenaf has many advantages over jute from the cultivator's point of view. Thus, it is not so exacting regarding soils and environment, while its cultivation can be mechanised easily.[6]

The fibre is, in fact, superior to jute for the coarser fabrics from which sacks and wrappings are made: it is stronger and more durable so that filled sacks may be dropped from a greater height without splitting. The bulk of the fibre produced is used for these coarser wrappings; for finer fabrics the West can rely on increased plantings of flax, ramie and other fibres of this class.

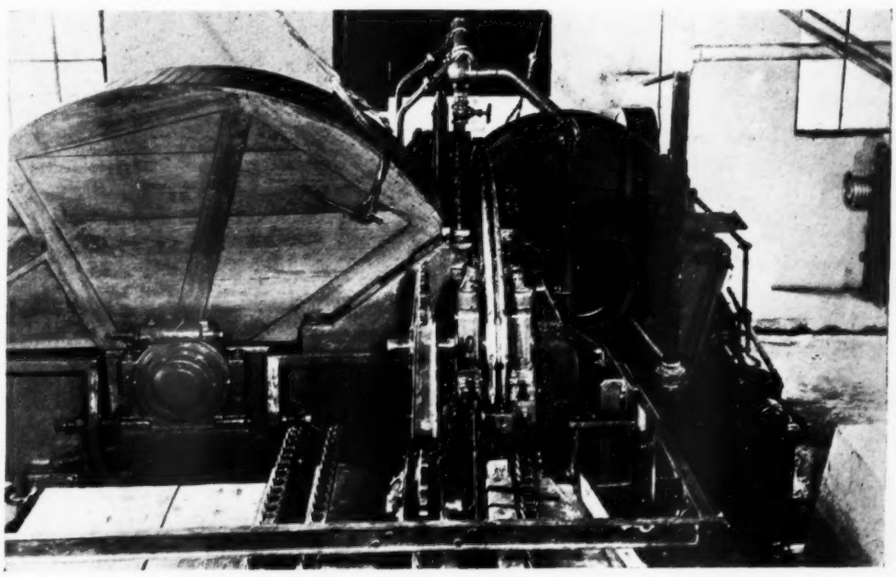
Types of Kenaf

It has been found that two kinds of fibre occur within the Kenaf stem, one primary and more flexible, and the other secondary and coarser.[7] The outer primary fibres are apparently formed by the terminal meristem, while the inner secondary fibres are formed by the cambium layer. Individual plants vary in their contents of finer more flexible fibres, which may range from 38% to 56%, and it seems possible that a great deal may be done to increase the fineness and flexibility of Kenaf by selection and breeding.

Kenaf is derived from *Hibiscus cannabinus L.*, the natural home of which may be Africa, since the plant is found growing wild in all latitudes from north to south of the African continent, where its photo-



Japanese-made decorticating machine; right side view



Stella Krupp machine for decorticating henequen; front view from the feeding platform

periodic response must, and indeed does, vary, according to the latitude in which it is grown.[5] The material used in the Cuban trials is said to be short day, consequently when the period of 12 hours of daylight approaches, all the plants initiate flower buds no matter when the sowing was made.[6] If a sowing is made too close to the flowering season all the plants grow stunted, and the effect of the long days is to prolong the growing season and thus produce tall growth. Korean and Manchurian stocks appear to have a different response, for they did not prosper in the Cuban latitude.[9]

The plant always grows tall in Africa under propitious circumstances. It is prolific on the west coast and grows well on the Equator in East Africa, where the writer has collected specimens from plants more than 8 ft. tall. The Russian material originated from the shores of the Caspian in Persia, and probably from Manchuria, and their plant breeders have made no secret of a desire to obtain material from Africa.[10] It seems, therefore, that geneticists should investigate the African material far more than they have done hitherto. Indeed, on account of the urge to establish an industry in South Africa,[3] seed has been introduced from Brazil and elsewhere, instead of laying down a collection of African types, which seems surely to be desirable.

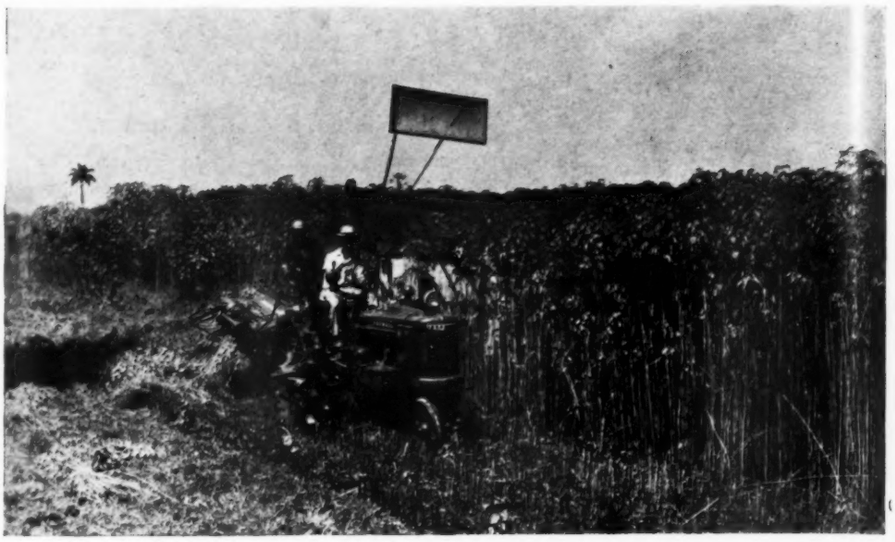
Mechanisation

Kenaf cultivation on a large scale would be impossible in the Western Hemisphere if it were not for the possibility of mechanising every stage of production, since the shortage and high cost of labour prohibits hand cultivation and preparation. South Africa still rets the fibre, and overcomes the problem of harvesting at the critical time by reaping and drying the straw, which is then stored and retted at leisure. It has been proved that the highest yield of the best-quality fibre is obtainable after the first flowers have opened but before the lower seed capsules have matured. This critical time may last 8 to 14 days, during which time all the stems must be harvested if it is desired to avoid producing coarse fibre. On the other hand, if the stalk is cut earlier the fibre is much weaker.

If South Africa can devise ways of simplifying and cheapening the retting process and fibre extraction after retting, for which jute softener machinery is at present being used, she may prove wiser than the United States, where dependence is placed on by-passing retting by decorticating the green stem direct.

More than ever is the critical time of harvesting important when the mechanical decortication of the green stem is undertaken, since if the stem is not sappy and is the least bit dry, the percentage of fibre wastage becomes considerable. The tendency is to decorticate the stem when it is too young and green, in order to avoid the waste, and it is often a problem to arrange for the decortication of the stalks from a big area within the short critical period. It would seem that the only alternatives are either the erection of very large central factories capable of dealing with the large amount of material derived from the harvest in a reasonably short space of time, with the disadvantage that they must stand idle for the rest of the year unless alternative fibres can be found for the treatment of which they can be used, or a fleet of mobile decorticators must be provided capable of dealing economically with the crop in the field.

Engineering firms of many countries are today interesting themselves in developing new types of machinery for the decortication of Kenaf stalks. So far reliance is being placed mainly on the Krupp Stella Henequen decorticator, modified versions of which adapted to Kenaf decortication have appeared during recent months. With some of these it is stated that under favourable conditions the recovery of fibre has been raised to 75%.



Kenaf can be harvested mechanically at the rate of approximately one acre an hour

Photos: U.S. Department of Agriculture.

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Kenaf in Australia and New Guinea

As a pendent to the foregoing article our Australian correspondent informs us that interest in Kenaf is also developing in Australia. It appears that experiments with the plant have been in progress in New South Wales since 1942, while more recently the possibility of developing an industry in New Guinea has come to the fore. The New Guinea Department of Agriculture have been growing the crop for the production of seed at their experiment stations in Keriwatt and Bereima, while a Sydney firm is taking an active interest in Kenaf production in New Guinea and has imported a decorticating machine.

RESEARCH DEVELOPMENTS

Control of Red Spider

A PROBLEM which faces horticulturists everywhere is the control of the red spider mite *Tetranychus telarius* and its allies. BHC and DDT are not toxic to it. Toxaphene is indifferently successful against the adults and has little ovicidal effect. The phosphorus contact insecticides, despite their high toxicity to the motile stages, have shown no great promise as ovicides.

Moreover, in Britain and elsewhere red spider on glasshouse crops has developed resistance to Azabenzene, which, in any event, although it is an excellent ovicide, kills the adults very slowly indeed.

The slow action of azobenzene on the adults, coupled with the occurrence of resistant resting stages, are factors which have contributed to the failure of what the trade calls ' straight azobenzene smokes ' and at present smoke canisters commonly contain parathion to kill adult spider, and azobenzene which assists the parathion and deals with the eggs. There is evidence that parathion-resistant strains of red spider have developed on roses under glass in the United States, where aerosol bombs generally are employed instead of smokes. It has been found that by changing the aerosol charge to HETP or EPN 300 parathion-resistant spider can be controlled, but never quite wiped out.[1]

There is as yet no evidence that red spider resistance has been built up against systemic insecticides, yet this possibility should not be overlooked.

After examining some 50 compounds, characterised by two benzene nuclei joined by various bridge groups, Eaton and Davies have recently concluded that there is no parallelism between the toxicity of the compounds to the eggs and to the adults of *Metatetranychus ulmi* (Koch), the fruit tree spider. Among the more promising compounds they found azoxybenzene, azobenzene, diphenyl sulphone and the 4-chloro derivatives of the two last.

Marketed in the United States by the Dow Chemical Company is another rather remarkable acaricide known as K6451. It is remarkable because, although it is highly toxic to red spider eggs, it has very low toxicity to the motile stages. Moreover, the material at as low concentrations as 0.3 lb. per 100 gal. of spray fluid remains toxic to eggs laid several weeks after the spray has been applied; its most curious property, however, is that of being able to kill eggs by acting through the thickness of a leaf.[2, 3]

An unexplained fact is that, while Dow workers found K6451 to be much more toxic than 4-chlorophenyl ester of benzene sulphonic acid, tests in Britain have shown that the latter compound is roughly as good an ovicide as the former.

It was an obvious step to link in the same formulation the rapid killing power of a phosphorus contact insecticide with the high ovicidal activity of K6451, and this has resulted in a series of interesting new Dow patents.

The patents claim synergism between K6451 and TEPP, DDT, BHC and Aldrin.[4, 5, 6, 7, 8] In particular the patent covering the joint use of DDT and K6451 is of considerable practical interest. Neither of these materials alone is capable of killing either red spider adults or aphids at the concentrations stated. Mixed they are revealed as a very potent combination and because of the very low mammalian toxicity of the constituents the mixture may prove a valuable alternative to the use of HETP or parathion.

From the theoretical aspects synergism between DDT and K6451 is of interest; it remains to be seen whether synergism exists between 4-chlorophenyl ester of benzene sulphonic acid and DDT. Perhaps the slight similarity in chemical structure between DDT and K6451—both materials have linked chlorbenzene nuclei—is a factor encouraging their mutual action.

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Antibiotic Substances Found in Panama Disease-Resistant Bananas

DURING 1949-50 year the important observation has been made that banana plants resistant to attack by *Fusarium oxysporum cubense*, the cause of the Panama disease, harbour in their root system certain bacteria which produce antibiotic substances highly active against fungi and other micro-organisms. In the root systems of the Panama disease-susceptible *Gros Michel* variety of banana such bacteria are apparently absent or very rare.

This information is contained in the 7th Annual Report of the Colonial Products Research Council (H.M.S.O. Cmd. 8063. 3s. 6d.).

The report goes on to say that in 1942 Meredith reported the isolation from a Jamaican soil of an actinomycete which was toxic to the *Fusarium oxysporum cubense*. Following upon further work by Dr. Thaysen and his collaborators, Drs. Arnstein, Cook and Lacey, working in the Imperial College of Science and Technology, found that the actinomycete gave a mixture of pigmented strains. From the fluid culture of the red strain an antibiotic, musarin, was isolated which was a powerful anti-fungal agent, but less effective as an anti-bacterial antibiotic.

From material provided by Dr. Thaysen, Professor Hassall and Miss L. Wong, working in the University College of the West Indies, have made a further study of Meredith's actinomycete, from which they have separated seven strains. Only one of these, a green strain, yielded an antibiotic. This differed completely in its properties from musarin and has been designated monamycin. It is highly active against gram-positive bacteria, but it has no activity against gram-negative organisms.

This is the first joint investigation by the Colonial Microbiological Research Institute and the newly founded University College of the West Indies.

Combined Fertilisers and Crop Protection Products

FARMERS of the future will save time, effort and money by using a single material that will not only fertilise crops, but also perform other useful services, such as the control of weeds, pests or diseases in the same application.

Already certain fertilisers and insecticides are being mixed and have given excellent combination results.

A. L. Mehring, soil scientist of the U.S. Department of Agriculture, presented a review of such developments at a recent meeting of the American Society of Agronomy, which is reported in the April-May issue of *Crops and Soils*, published by the Society.

An example of a fertiliser that may also be used to kill weeds is calcium cyanamide. When applied at high rates on tobacco seed beds or lawns well before planting it tends to kill all weeds and fertilise the desired plants.

Potassium cyanate is a selective herbicide which kills crab grass and some weeds, but when applied according to directions does not appear to harm most grasses, onions or a few other crops. Upon reaching the soil it becomes a good source of nitrogen and potash for growing crops.

Lawn fertilisers with added 2, 4-D to control weeds have been on the market for several years, and now experiments are under way to perfect combinations for use in pastures and on small grains and sugar cane.

Picking Sea Island cotton, West Indies

Cotton Production in the British Commonwealth

Increasing shortages of cotton supplies accentuated by difficulties resulting from lack of dollar exchange have thrown into prominence efforts to stimulate cotton production in the countries of the British Commonwealth. These have for many years been assisted by the Lancashire cotton industry through the operation of the British Cotton Growing Association and the Empire Cotton Growing Corporation. The production of cotton in the British Commonwealth during the year 1950 is reviewed in the annual reports of these two bodies from which the following account has been extracted.

SHORTAGES in dollar exchange and the growing demand for cotton textiles have caused increased interest to be attached to cotton production in the territories of the British Commonwealth of recent years.

Attention was first paid to this matter at the beginning of the present century when the British Cotton Growing Association was formed in this country, as a result of the initiative of the Lancashire cotton spinners and with the active support and encouragement of H.M. Government, with the object of helping to develop production within the British Empire. The Association assisted in a variety of ways by the provision of advice, guidance and ginning machinery and in the marketing of the cotton crops. In 1922 the Empire Cotton Growing Corporation was inaugurated with the object of assisting developments in the Empire through the provision of scientific services directed towards the improvement of cotton in the various Commonwealth countries.

As a result of the operation of these two bodies, together with the active support of the Governments of the U.K. and territories concerned, thriving cotton industries have been built up in various parts of the Commonwealth. Prior to the inception of these activities Commonwealth cotton production was negligible, apart from India.

At present, total production of cotton in Commonwealth countries, excluding India and Pakistan but including the Anglo-Egyptian Sudan, is roughly 900,000 bales

ANNUAL COTTON PRODUCTION IN THE COMMONWEALTH, 1943-1950

	1943	1944	1945	1946	1947	1948	1949	1950
Anglo-Egyptian Sudan:								
Sakel type	347,100	214,200	365,400	237,900	278,300	263,300	316,700	334,400
American type:								
Irrigated	3,600	3,600	4,200	2,700	2,300	3,500	4,600	5,600
Rain-grown ..	3,400	3,200	4,700	1,800	1,800	10,200	19,000	20,000
Total Anglo-Egyptian Sudan	354,100	221,000	374,300	242,400	282,400	277,000	340,300	360,000
East Africa:								
Uganda	113,000	190,000	272,000	227,900	232,200	170,000	391,000	340,000
Tanganyika	38,300	24,800	40,400	41,100	40,000	53,800	51,300	49,200
Kenya	5,500	6,300	5,400	5,100	5,200	4,900	9,800	8,000
Nyasaland	5,500	9,000	9,000	9,100	11,200	13,700	2,500	10,700
Total East and Central Africa	162,300	230,100	326,800	283,200	288,600	242,400	454,600	407,900
Nigeria:								
Northern	26,000	18,600	13,200	34,500	34,600	21,700	51,100	61,200
Southern	7,300	6,200	2,700	2,800	50	100	50	1,100
Total Nigeria ..	33,300	24,800	15,900	37,300	34,650	21,800	51,150	62,300
West Indies	4,500	4,100	4,500	3,800	2,600	3,900	6,700	5,100
Southern Rhodesia ..	1,400	1,600	1,250	850	400	700	2,100	5,100
Union of South Africa	600	700	350	350	1,100	2,700	5,200	7,000
Australia	8,400	7,400	1,900	2,800	2,000	1,800	700	1,000
Sundries	1,700	1,300	2,400	2,000	2,000	2,200	3,000	7,000
Grand Total	566,300	491,000	727,400	572,700	613,750	552,500	863,750	855,400

of 400 lb. Although this is still small compared with the estimated total world production of approximately 33,000,000 bales, it is by no means negligible. Under the influence of increasing demand and favourable prices production is expanding rapidly and if present conditions continue it is highly probable that Commonwealth production will increase considerably during the next few years. The present position of cotton production in Commonwealth countries is reviewed in the recently published reports of the two corporations for the year 1949-50, from which the following summary of the position has been extracted.

COTTON PRODUCTION IN THE PRINCIPAL AREAS OF THE ANGLO-EGYPTIAN SUDAN, 1949-50

	1949–50		1948–49	
	Area (feddans)*	*Bales of 400 lb.*	*Area (feddans*)*	*Bales of 400 lb.*
Sakel type:				
Gezira (S.P.S. and K.C.C.)	206,737	254,671	206,778	244,224
Tokar	30,260	8,823	20,685	7,246
Kassala (Gash Delta)	44,840	27,105	46,537	26,418
Others	37,079	43,740	33,241	38,793
Total	318,916	334,339	307,241	316,681
American type:				
Irrigated	6,768	5,615	5,001	4,596
Rain-grown	88,680	20,014	75,291	19,028
Grand Total	414,364	359,968	387,533	340,305

*Feddan = 1.038 acres. 1 Kantar = 312 lb. seed cotton.

General

The annual production of cotton in Commonwealth countries for the past eight years in terms of bales of 400 lb. each is shown in the table on page 357.

Anglo-Egyptian Sudan

There was again an increase in cotton production in the Anglo-Egyptian Sudan in the 1949-50 season, the total being approximately 360,000 bales (400 lb.) compared with 340,300 bales in the previous season. It is the second largest crop the country has produced. The Sakel and Sakel-type crops were larger by about 17,500 bales; the American irrigated and rain-grown crops also show some increase.

The table above gives particulars of the principal areas under cotton and production together with the figures of the previous season.

In the Gezira the areas under cotton on the schemes of the Sudan Plantations Syndicate Ltd., and the Kassala Cotton Co. Ltd., were much the same as before. Weather conditions were more favourable than in the previous season, and in both quantity and quality the crop was well above average, with a far larger proportion of top grade cotton than has been the case for some years. Spraying against Jassids was again carried out on a wide scale. The cotton crop of the two companies amounted to 946,530 kantars, equal to 254,671 bales (400 lb.), compared with 244,224 bales in the previous season; it is the second highest crop so far produced—the previous best being in the 1944-45 season, when production was over one million kantars, or 277,735 bales.

On the White Nile Alternative Livelihood Schemes (Government pump watered schemes), of which Abdel Majdid is the largest, 16,542 feddans of Sakel-type cotton were planted—yielding approximately 21,100 bales (400 lb.). On a number of private pump watered estates on the White Nile 19,718 feddans produced approximately 21,900 bales.

As regards the areas under flood irrigation: a considerably better flood than in the previous year in the Tokar Delta, although still well below average, watered 30,260 feddans, rather more than in the previous season; the resultant crop was also larger, amounting to 8,823 bales, against 7,246 bales in 1949. In the Gash Delta (Kassala), despite a low volume of water (the flood was one of the lowest on record) the area watered was almost as large as the record acreage of the previous season; 44,840 feddans were established, only a little less than in the previous year, and the yield of approximately 27,000 bales was the second highest.

Production of American rain-grown cotton in Kordofan and Equatoria has risen considerably in the past two seasons, after the low figures during the war years when food production was of first importance. In Kordofan in 1949-50 the area sown to cotton was increased from 65,806 feddans to 76,030 feddans, but a low yield owing to badly distributed and insufficient rainfall resulted in a smaller crop, *viz.*, 16,100 bales, as against 16,500 bales in the previous year. In Equatoria Province there were considerable increases in both area and yield, the crop being approximately 3,900 bales, compared with 2,500 bales in 1948-49. Production from these two provinces was thus about 20,000 bales (400 lb.), compared with 19,028 bales in the previous season.

As regards the irrigated American crop: on the estate of the Zeidab Plantations Co. Ltd., formerly owned by the Sudan Plantations Syndicate Ltd., there was a small increase in the cotton area; in addition some 1,484 feddans were put under cotton on other estates, making the total area 6,768 feddans. Production amounted to 5,615 bales (400 lb.) against 4,596 bales in the previous season.

On July 1, 1950, the Sudan Gezira Board took over the management of the Gezira scheme. The Government have stated that it is their intention to devolve full responsibility for the management of the scheme on Sudanese as quickly as possible without endangering efficiency; towards the fulfilment of this some Sudanese field inspectors have been appointed and the selection of others to fill impending vacancies is in progress.

Uganda

Cotton production was a little lower in the 1949-50 season than in the previous season, the total amounting to approximately 340,000 bales, as against 391,000 bales. Nevertheless, it was the third highest crop the Protectorate has harvested.

The delay in the onset of the spring (1949) rains and the necessity of ensuring future food supplies meant that a high proportion of cotton planting was late. Large acreages were cleared for planting and there were keen demands for seed, but planting was not completed until late August and September. The final acreage figures with, for comparison, those of the two previous seasons, were as follows:

Province	1949–50	1948–49	1947–48
Buganda ..	546,944	499,267	305,663
Eastern ..	695,451	767,826	524,437
Western ..	22,380	27,376	19,950
Northern ..	363,743	266,969	186,779
Total ..	1,628,518	1,561,378	1,036,829

The crop made good growth in the early stages, although the high percentage of late plantings made it probable that the yields per acre would be low and a crop smaller than the previous year. Hot and dry weather was experienced in October and well into November, resulting in much boll shedding, and rainfall above average in December caused further loss of crop in the Eastern Province. However, purchases in the Buganda Province were higher than expected, and the earlier estimate of 320,000 bales was exceeded by approximately 20,000 bales. The incidence of

pests and diseases was reported to be less than usual.

Transport of bales to the coast was slow owing to the shortage of rolling stock.

The marketing of raw cotton in Uganda is now the responsibility of the Lint Marketing Board which was set up by the Government towards the end of 1949. The Board controls and fixes, at the beginning of the season, the prices to be paid to producers for their seed cotton, and is the sole channel through which ginners sell to exporters.

Actual production (in bales of 400 lb.) in the past three years has been:

1949-50	1948-49	1947-48
339,884	390,879	168,919

The exports and f.o.b. Mombasa values for 1950 and the two previous years are:

	1950	1949	1948
Bales	339,507	389,956	174,257
Value	£16,331,335	£17,340,215	£7,457,617

Of the 1950 exports, approximately 212,900 bales were shipped to India and 106,850 to the United Kingdom. Japan took 9,400 and Southern Rhodesia 5,000 bales.

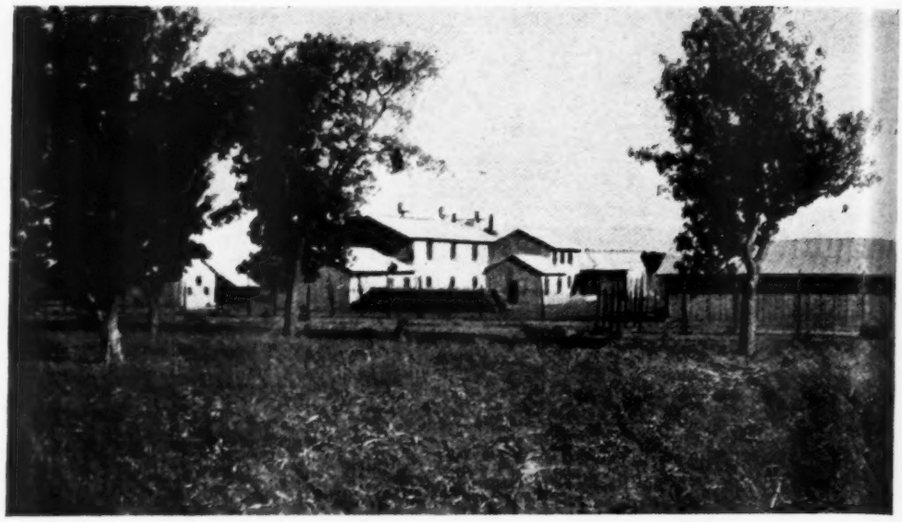
The Cotton Tax collected during 1950 amounted to £2,850,000, compared with £2,563,000 in 1949 and £1,106,371 in 1948.

The new electrically-driven saw ginnery at Mbale was only able to operate part of the year due to delays in arrival of the machinery, but handled nearly 3,000 bales. This is regarded as an experiment, and the results so far obtained are encouraging and it is hoped will be of value to the Uganda industry.

The new Cotton Research Station which the Empire Cotton Growing Corporation have established at Namulonge, near Kampala, was officially opened on November 9 by H.E. the Governor of Uganda, Sir John Hathorn Hall, G.C.M.G. At this station the Corporation are concentrating the investigations which were previously in progress at their research station in Trinidad and their main experimental station at Barberton in South Africa, with which stations in Swaziland and Natal worked in co-operation. With the new station will be closely linked the work in progress in the Sudan, Tanganyika Territory, Nyasaland and Nigeria. About 15,000 sq. ft. of laboratories have been built and it is hoped that 1,500 acres will eventually be under cultivation for the study of the basic problems of cotton growing in Africa.

Tanganyika Territory

The cotton crop harvested in 1950 showed a slight decline from that of 1949, the total being estimated at 49,200 bales, compared with 51,300 bales in the previous season. The chief producing area is the Lake Province, and the 1950 crop of 38,900 bales is the best since 1948.



The ginnery at Mallamfashi, Northern Nigeria

Weather conditions on the whole were favourable for cotton, although in some areas the start of the rains was delayed. This was particularly so in the Lake Province, where food crop planting, of necessity, had first call and therefore cotton planting took place later than usual, up to as much as two months later than is desirable. American bollworm caused very considerable losses. Its high incidence in the Lake Province is in part attributed to the breeding-up that took place in early plantings of maize, which is in fact not an important food crop, in the cotton areas of the Lake Province. Cotton was attacked from the end of February, developing seriously from early April. Losses were particularly noticeable on the late-planted cotton. Under more favourable conditions, the area planted would have produced appreciably more than the 38,905 bales actually realised. In the Eastern Province weather conditions, particularly early in the season, were good and planting was more extensive than in the previous year, but the crop suffered from a severe American bollworm attack. In addition there was a general outbreak of field mice which caused very considerable losses late in the season. In the Ulanga district the lateness of the rains resulted in late planting, which, in spite of a large acreage, produced a disappointing crop. The Rufiji districts produced an excellent floodlands crop with a remarkably low percentage of stained cotton. The net result was that the Eastern Province produced a crop of 8,408 bales (estimate) only as compared with the previous season's 12,579 bales. The Southern Province experienced a poorly distributed rainfall, although the total precipitation was above average, and a crop of only 172 bales was harvested. Weather conditions varied in the Tanga Province, and as elsewhere the incidence of insect damage was heavy and late rains have delayed picking. The Northern Province experienced less insect damage and with a noticeable increase in the area planted to cotton in the Moshi District a crop of over 1,000 bales is anticipated.

Production figures are as follows (in bales of 400 lb.):

Province	1940–49 *Average for 10 years*	1949	1950
Lake ..	35,122	37,361	38,905*
Eastern ..	9,786	12,579	8,408†
Northern ..	1,255	398	1,051†
Tanga ..	1,010	666	671†
Southern ..	753	304	172*
Total ..	47,926	51,308	49,207

*Actual. †Estimate.

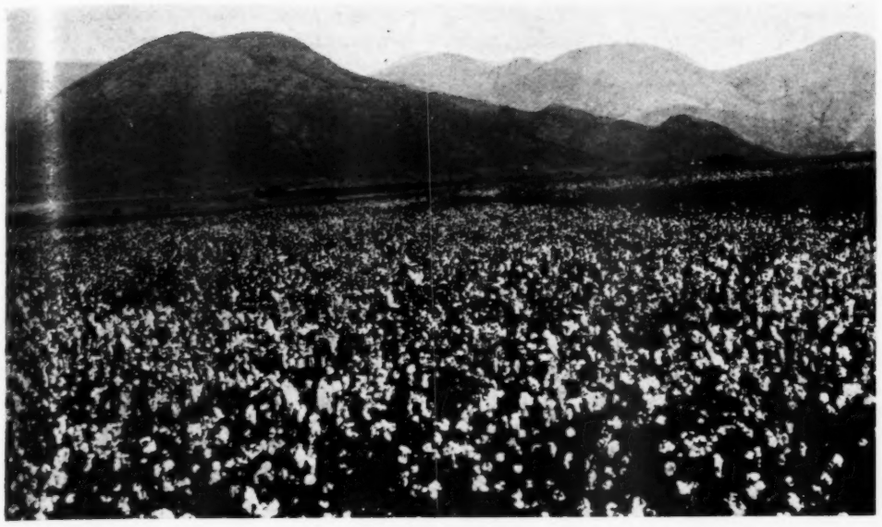
Kenya Colony

Cotton production in the 1949-50 season was a little less than in the previous season, being just under 8,000 bales against 9,700 bales in the previous season.

Increased prices to growers in the 1948-49 season, coupled with a strong desire to reinstate the cotton crop in the important position it used to hold in the Nyanza Province, and much propaganda from the field officers concerned, led to a revival in interest which was maintained in the following season.

The total acreage under cotton in the 1949-50 season was:

Nyanza Province: 41,500 acres (1948-49 acreage: 35,000 acres).



Looking across the plots of a variety trial at South Africa's Cotton Experiment Station at Barberton

Coast Province: 8,500 acres (1948-49 acreage: 8,000 acres).

In Nyanza Province the rainfall can best be described as average, though in lake shore areas it was inclined to be poor and in higher areas good and well distributed. Lake shore areas in Central Nyanza, particularly, suffered from drought and there was some severe hail damage in North Nyanza. Fair rainfall in December and January in some places induced a small, dirty, late top-crop. Good growing weather was not taken advantage of in many areas of North Nyanza where planting was late. The scourges of Lygus and Black-arm, so common to Nyanza, followed upon each other and must have reduced the crop considerably. Black-arm was most severe in South Nyanza. Stainers were in evidence in many areas.

In Coast Province rains were a complete failure with resultant minimum yields.

The following are the production figures for the past three seasons:

Province	1949–50	1948–49	1947–48
	Bales	Bales	Bales
Nyanza ..	7,045	7,267	1,212
Coast ..	928	2,447	3,655
Total ..	7,973	9,714	4,867

The results in the past two seasons are the best since 1942, when production was over 12,000 bales.

Nyasaland

Production of 10,700 bales (400 lb.)—9,400 bales on native trust lands and 1,300 bales by tenants on private estates—is a favourable recovery from the 2,200 bales in 1949 produced under severe drought conditions, and is in line with the average for the five years 1944-48, *i.e.*, 10,400 bales.

Seed distribution began in the Southern Province in December (1949) although at that time farmers were more concerned in establishing their food crops. Moreover, an extensive planting campaign was started in the autumn of 1949 to ensure that maximum food supplies should become available from the early 1950 harvests. Consequently the demand for seed was much below normal, the Chikwawa district being the only main growing area where the demand was normal. Favourable weather prevailed at planting time; germination and early growth were for the most part good, but later temperatures and rainfall were below normal. Bollworm and stainer infestation in most of the Lower River Area were reported to be less than it was two years ago. The Southern Province total was 9,800 bales.

In the Central Province production was again negligible; tobacco appears to be more attractive to the local farmers.

In these two Provinces the proportion of first-grade cotton was reduced to 85.45%, compared with 88.74% in 1949.

In the Northern Province, where the crop is planted and harvested much later than in the other two Provinces, production was approximately 700 bales, about double that of the previous season.

Transport from the cotton markets to the ginneries was satisfactory, in spite of the poor condition of some of the roads in the Lower River area. The new bridge over the Shire River at Chiromo, built to replace the old bridge which was washed away in March 1948, was completed early in the year, and this helped the railway authorities in their prompt evacuation of the bales to the port of Beira.

The newly formed Government organisation created to attend to cotton development took on the role of cotton buyers on African Trust Lands (or Crown Lands) for the first time.

Nigeria

Northern Provinces: The total of 61,218 bales of 400 lb. (57,507 bales of Allen cotton and 3,711 bales of Ungraded Benue) in the 1949-50 season was an increase of 10,000 bales over the previous season's total, *i.e.*, 51,102 bales, and is the second best total ever exported, the highest being 68,440 bales in the 1940-41 season.

The demand for seed for planting was heavy, stimulated by the increased price paid the producer for his seed cotton in the previous season, *i.e.*, 4d. per lb. for Grade I at all markets, while the fact that the planting rains started late made the planting of cotton a better prospect than that of groundnuts, this resulted in a considerably greater acreage than for a number of years—no official figures of acreage are compiled. The quantity of seed distributed for planting was 7,576 tons; it was the largest for nine years, and compares with 6,468 tons in the previous year.

Growing conditions, however, were generally poor throughout the season as only light rains were experienced to the end of September, and yields were below average. Although damage from insect pests was less than last year (notably that of pink bollworm) the loss of yield through insect pests, the principal being red bollworm and Stainers, is still considerable.

The availability of adequate supplies of cotton piece-goods at reasonable prices meant a greatly reduced demand for cotton by the local spinning and weaving industry, and the table below gives the details by Provinces and ginneries of the quantity exported:

NORTHERN PROVINCE, NIGERIA: COTTON EXPORTS, 1949 AND 1950

Province	*Ginnery*	*Bales of 400 lb.*	
		1950	1949
Allen Cotton (NA)			
Zaria ..	Zaria	13,835	11,268
Katsina ..	Funtua	15,010	13,627
	Mallamfashi	8,562	8,446
Sokoto ..	Gusau	7,280	5,840
	Mai-Inchi	8,223	6,504
Bauchi ..	Bauchi	885	498
	Misau	390	283
Niger ..	Kontagora	2,610	1,276
	Lokoja	470	161
	Oshogbo	242	—
		57,507	47,903
Ungraded BenueCotton			
Niger ..	Lokoja	3,711	3,199
	Total	61,218	51,102

Quality was up to standard, and the proportions of NA grades was about the same as in the previous year, *viz.*, 85.10% for NA1 (compared with 84.68%) and 14.90% for NA2 (compared with 15.32%).

A Cotton Marketing Board has been appointed whose functions are briefly, to develop and expand cotton growing, control the primary marketing of the crop, and the sale of the bales. Under the Board is a Cotton Development Team whose work is to encourage the maximum production of cotton by co-ordinating the work of all concerned. The Board functioned for the first time during the season under review, but the Development Team did not commence work in the area until seed for planting had been distributed and planting of the crop had taken place.

As will be seen from the figures already given of the last two crops, *i.e.*, those marketed in 1949 and in 1950, cotton growing has recovered from its rather lowly position in the period when cotton growing received little or no official encouragement and was practically sacrificed to the growing of other urgently required crops, to the position it held in the immediate pre-war and the early war years.

South Africa

The 1949-50 crop of 7,016 bales was the largest for nearly 20 years in spite of unfavourable conditions. In Natal over half the crop was lost through an attack of bollworm, and in the Transvaal drought in February and March, followed by heavy rains in April, led to bollrot and consequently very low yields. Little cotton was planted in the Orange River area owing to drought and lack of irrigation water.

In the 1950-51 season sufficient seed was issued to plant 60,000 acres but, owing to the late arrival of the planting rains, only about 40,000 acres were actually planted. In all areas good rains were experienced in December and early January, but these were followed by a drought lasting six to eight weeks.

Insect pest attack was again heavy and two helicopters and two power sprayers were used in the Magut area early in March. In the Barberton area also most growers were dusting their cotton with a good measure of success. The small machines in use, however, were not always very efficient.

The irrigated crop along the Lower Orange River consists mostly of Improved Bancroft, U4 selections being less suitable for growing under irrigation. The staple varies from full $1\frac{1}{8}$ in. to $1\frac{1}{4}$ in., and the lint is exceptionally silky, soft and strong. Yields this season are expected to be very high, a figure of two to three bales an acre being mentioned as probable.

Australia

Total production of cotton lint in Queensland for the 1949-50 season amounted to 1,005 bales. The ginning percentage was 36.3, the highest yet recorded; the average grade was middling and the staple length 29-32 in.

Rain at harvest time greatly interfered with both hand and machine picking and was probably mainly responsible for the lower grades obtained; 16% of the total crop was mechanically harvested, 36% was hand snapped, and 48% was hand picked.

For the 1950-51 season seed sufficient to plant over 7,000 acres has been applied for, nearly double that of last year. Good planting rains occurred in October and November and germination of the crop was good. A short dry period with moderately high temperatures occurred in December. This toughened the plants and allowed a deep rooting system to develop. Further beneficial rains occurred later and the estimated yield for the current season is 1,600 bales of lint.

Aden

A new and promising cotton-growing industry has recently been started in the Abyan area of the Aden Protectorate. A few years ago a small amount of seed of X1730A Sudan cotton from Tokar was sent to Aden for trial. In 1948-49 some 80 acres were planted, producing about 120 bales of lint, and in the following year over 1,000 acres were grown producing 1,587 bales.

For the current season, 1950-51, approximately 6,000 acres have been sown, the yield being estimated at 7,000 bales.

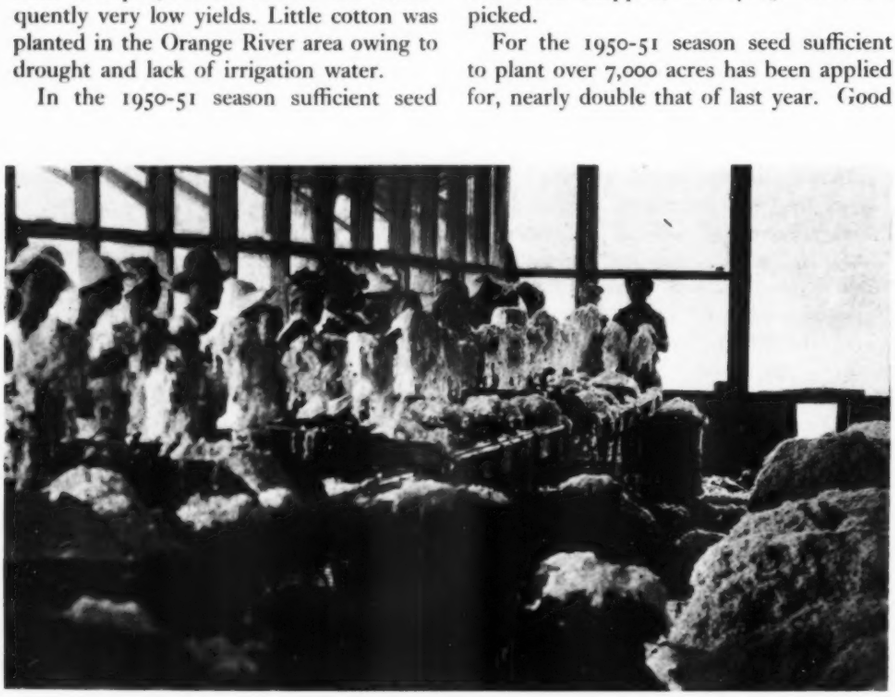
Cotton is grown on flood land as in parts of the Sudan, and also as in that country, it is grown on a co-operative basis, the proceeds being divided between the cultivator, the Abyan Board, the landowner and the State. Although production is never likely to be very large it has been estimated that, on a conservative basis, some 25,000 acres could be flooded each year, of which one-third could be planted to cotton. Tests of the lint carried out in Lancashire have shown that the yarn spun from it is little, if any, inferior to that spun from similar cotton grown in the Sudan. A Colonial Office Mission recently visited the area to examine the technical, agricultural and financial problems involved and to make recommendations for the development of the scheme and the establishment of any research work that may be needed.

West Indies

The area planted to Sea Island cotton in the 1949-50 season amounted to 13,526 acres, compared with 16,036 acres in 1948-49; production was also less, being estimated at 5,000 bales (400 lb.), compared with 6,332 bales in the previous season.

The details of the acreage and production of the 1949-50 crops in the different islands, supplied by the West Indian Sea Island Cotton Association, are given in the next column:

In St. Vincent the crop of 1,097 bales was an increase of 237 bales on the previous season, but in the other islands smaller crops were produced. In Montserrat pink bollworm reduced production.



Ginning Sea Island cotton, West Indies

SEA ISLAND COTTON: ACREAGES AND PRODUCTION, 1949–50

Island	*Acres*	*Bales of 400 lb.*	*Lint production in lb. per acre*
Antigua ..	3,949	2,095	212
Barbados ..	386	86	90
Montserrat	3,576	1,000*	†
Nevis ..	1,414	386	109
St. Kitts ..	830	342	165
Anguilla ..	60	10	69
St. Vincent	3,311	1,097	133
Total ..	13,526	5,016	148

*Estimated. †Not available.

As regards the *Marie Galante* type of cotton, which is now only grown in Carriacou, production is estimated to be about 100 bales.

Conclusion

While a production in 1950 of 855,400 bales (400 lb.) in the Anglo-Egyptian Sudan and Empire countries is some 8,000 bales below that of the previous year, the total for the two years averages near 860,000 bales per annum and is an achievement that has only once previously been attained—884,000 bales in 1938.

The Anglo-Egyptian Sudan and Uganda account for 700,000 bales of the 1950 total—the former with a crop of 20,000 bales more than in 1949, but Uganda, though having about 4 per cent. increase in acreage, produced 50,000 bales less than in 1949, due to dry weather conditions in the normal planting period and again later in the year when plants were nearing maturity. Nigeria gave a satisfactory increase of 11,000 bales, and Nyasaland production was a recovery to near its former position, following the prolonged drought of the previous year.

With the present world shortage of cotton it is satisfactory to know that the Governments of the various cotton-producing countries are aware of the necessity for bigger production, added to which is the very substantial contributions that cotton growing has made to the finances of these countries.

While no spectacular advance in the quantities of cotton produced are anticipated, there is every reason to hope that the figures of production in the last two years will not only be maintained but increased. The Anglo-Egyptian Sudan crop has for some time been steadily increasing—constant attention over the years to every phase from seed selection to harvesting, including the use of the most modern machinery in combating pests, has all helped to increase yields—but with the bulk of the cotton being produced under irrigated conditions, an expansion of the planted area is limited by the quantities of water that can be taken from the Nile; this is governed by agreement with Egypt. In Uganda no large increase in acreage is to be looked for, but the special efforts being made to improve the standard of cultivation and raise the average yield per acre will in time produce results—the aim is for crops of half a million bales or more. In both Nigeria and Nyasaland development teams have been appointed and are now at work with the main purpose of bigger crops of cotton.

Photo p. 357, Empire Cotton Growing Corporation.

NEW BOOKS

Farm Machinery

By A. B. Lees. Pp. 220, illustrated, Faber & Faber, London, 1951, 21s.

With the ever-increasing interest in farm mechanisation, books on the subject are multiplying rapidly and the work on farm machinery by A. B. Lees is the latest addition. The author was for many years machinery correspondent to the *Farmer and Stockbreeder* and is now an agriculturist to the Ferguson Farm Equipment Organisation. He is thus well qualified to deal with the subject.

In this book he discusses all the various aspects of mechanisation of the farm and deals with tractors, mounted implements, plough performance, grain harvesting and drying, seed and fertiliser distribution and a variety of other farm operations.

A lengthy section is devoted to electricity on the farm and the various ways in which it may be applied to farming practice are discussed. The book is very readably written and profusely illustrated with line drawings and a large number of excellent photographs. It is written particularly for the use of farmers in this country, but there is much information in it which should be of use to farmers and planters overseas.

It can be recommended to all who wish to have a handy and concise work to refer to on the subject.

British Farming

By W. B. Mercer, C.B.E., M.C., B.Sc., N.D.A. Pp. 96, illustrated, H.M.S.O., 1951, 3s. 6d.

The story of farming in Great Britain has been told before; nevertheless, this newcomer, describing in particular the progress made during recent years in providing food from Britain's fields, will be particularly acceptable this Festival year.

Mr. Mercer, who is Director of the National Agricultural Advisory Service for the West Midland Province, has prepared a text with the help of a number of other agricultural experts to produce a truly comprehensive story of British farming past and present. Opening with a short historic survey, dairy farming is rightly the first specialised chapter, for, as the book says, 'milk and milk produce represent more than quarter in value of all the output of British farmers.' A considerable part of this chapter is devoted to the importance of grass. Then follows an account of British beef production, emphasising the importance of grassland and the development of the beef animal. Sheep farming in the highlands and lowlands is described and a chapter is devoted to pigs and poultry.

To tell the story of arable farming in Britain in 14 profusely illustrated pages is no mean task, as far as the layman is concerned, at any rate. The authors of this section have told a well-balanced story, including the important crops and their problems, the famous fenlands and a short section on soil fertility. Other sections in this book cover ploughland in Scotland, market gardening and mixed farming in Northern Ireland.

From the foregoing the reader will gather that this book is written for the layman rather than the expert, in order that he might get a good idea of the scope and variety of British agriculture. For any visitor to the shores of Britain who intends to study the farming, he would do well to read this book as a prelude to his travels. For schools, too, this book should have an appeal; it is illustrated with 180 photographs, maps and diagrams.

East Malling Report

East Malling Research Station, Kent, Annual Report, 1950. Pp. 219. Illustrated. 1951, 10s.

The East Malling Research Station Annual Report for its thirty-eighth year covers the period from October 1949 to the end of September 1950. The general form of the Report follows its predecessors—Part I deals with the experimental farm; Part II contains accounts of investigations in progress in the various Sections and reflects the greater volume of work in hand consequent upon the increases in staff in recent years; Part III gives the research reports and reviews, while Part IV presents some of the results of research

and describes their particular application in seven 'Bulletins for Fruitgrowers.'

To select any one line of research for mention in this place would merely reflect the reviewer's particular interests, while so catholic is the work at the Station that any comprehensive account is beyond the scope of a brief review. The accounts of the research programme which comprise Part III are shortly stated; each report, however, is supported by a list of publications during the year, so that the reader may pursue a subject in some detail. Among the 29 papers in this Section are those on frost damage, special grafting and propagation methods, walnut varieties, the control of fruit drop, pests and diseases, and variety trials of hops for ease of picking and propagation.

Of the seven bulletins for fruit-growers, two are directly concerned with raspberries; others deal with research of fruit tree woodstock, mechanical aids to nursery work, virus diseases of sweet cherries, an important new type of wetter, and chemicals for the control of apple sawfly. They are practical, and will repay attention by fruit growers.

Sir Edward Salisbury, in his thoughtful Amos Memorial Lecture, 'The Fruit Tree and its Environment,' which is included in the Report, outlines the environmental conditions of the tree and points out that its health and vigour is necessarily constrained by the artificial limitations imposed in fruit culture. Our concept of a healthy tree, therefore, is one that is out of balance in the sense that it is a fruit factory with an abnormal emphasis on the reproductive phase. 'This,' he concludes, 'implies readjustment in every other aspect of the organism's activity and hence the need for that exhaustive study of fundamental physiology without which such adjustment will be based on luck rather than judgment.'

Sir Edward speaks of the close and sympathetic co-operation necessary between the skilled practice of the fruit grower and the basic knowledge of the scientific investigator. In this statement he has surely epitomised the relationship between the East Malling Station and the fruit growers. It is evident that the workers at the Station are conscious of this necessary liaison, for they so arrange and present their work in this Report that it may give full information to both scientists and fruit growers. East Malling was initiated by the Kent Incorporated Society for Promoting Experiments in Horticulture. The Station, however, does not merely serve these members, but the fruit-growing industry throughout the United Kingdom, while its influence is world-wide.

Report

Of the First International Conference for the Examination of Methods of Combating Plant Parasites. Held at Rome, October 3-6, 1950. Pp. 452. Tip Failli, Rome, 1951. (Papers printed in their original languages.)

We have received a copy of the report of this conference. It was organised under the auspices of the Confederation Internationale des Ingenieurs et Techniciens de L'Agriculture (CITA), an international body which has its centre in Rome.

At it some 14 countries were represented, but the great majority of the representatives naturally came from Italy. Representation from other countries was numerically small, while that from the United States consisted of two delegates only.

The Report is an interesting document containing papers on a variety of subjects, including the possibility of standardising analytical methods for crop protection products. It is, however, chiefly remarkable for the plea that is entered among its resolutions and findings for the establishment of some form of supra-national control in this connection.

This matter is referred to under an Editorial Comment in this issue.

Proceedings

Of the Second International Congress of Crop Protection. London, July 31, 1949. Pp. 521. Illustrated. Society of Chemical Industry, London, 1951.

We have received from the Society of Chemical Industry a copy of the proceedings of the Second International Congress of Crop Protection which was held from July 20-31, 1949.

The volume contains the papers in full, delivered before this Congress, which was one of the most important gatherings dealing with this subject so far held. It is thus rather late in appearing. However, much of the work recorded is of first importance, and no one connected with the scientific aspect of crop protection can afford to be without a copy on his shelves.

The volume is well produced. It can be obtained from the Society of Chemical Industry, 56 Victoria Street, S.W.1.

Two American Yearbooks

We have received copies of the 1951 editions of the American Tomato Yearbook and the American Potato Yearbook.

The Tomato Yearbook is edited by Dr. John W. Carncross and is profusely illustrated with charts and graphs, including statistical information on tomatoes in Canada, a breakdown by states of commercial varieties, a directory of business concerns serving the tomato field, a list of leading associations engaged in the tomato industry and information on the composition, food value and history of the tomato.

The Potato Yearbook is edited by John C. Campbell and contains 80 pages of information for the grower, shipper, dealer and, in fact, all those connected with the potato industry.

A new feature in this year's volume is the list of research projects with the names of individuals engaged in conducting research on Irish potatoes. There is also a complete and up-to-date list of more than 100 recent references to potato culture in the United States.

Other interesting items include articles on the origin and history of the potato, potato ring rot, rules and regulations affecting the shipment of seed potatoes, a list of leading United States and Canadian associations engaged in the improvement of the potato industry together with the names of the United States and Canadian seed certification officials.

Copies of both these Yearbooks may be obtained from the Editorial Office, 319 Scotch Plains Avenue, Westfield, New Jersey. An individual copy sells for $2.00.

New Publications

The following books, published recently, are available from the Book Department, WORLD CROPS, Leonard Hill Ltd., 17 Stratford Place, London, W.1:—

Biological Flora of the British Isles: Sinapis Arvensis. L. Jnl. of Ecology. Reprint. Cambridge University Press. 1s.

Early Potatoes. By W. L. Thomas and P. W. Eyre. Illustrated. Pp. 200. Faber. 18s.

Food, Farming and the Future. By Friend Sykes. Illustrated. Pp. 296. Faber. 21s.

Farm Business Management. By Robertson, S. Lynn and R. H. Wood. Illustrated. Pp. 546. Lippincott. 28s.

Forest Products Statistics Year Book, 1950. FAO publication. H.M.S.O. 17s. 6d.

Grassland and Grassland Products. By S. J. Watson. Illustrated, diagrams and tables. Pp. 200. E. Arnold. 21s.

Plant and Animal Nutrition in Relation to Soil and Climatic Factors. (British Commonwealth Scientific Conference.) H.M.S.O. 20s.

Production of Tomatoes Under Glass. Illustrated. Pp. 179. F. Benn. 10s. 6d.

Silage. By S. J. Watson and A. M. Smith. Illustrated and tables. Pp. 143. Crosby Lockwood. 10s. 6d.

Typical of the scenery in Central Finland are the coniferous forest and the lake

Agriculture in Finland

Part II Advisory and Educational Services

This second part of the article on Finnish Agriculture deals with the advisory and administrative aspects. Like its predecessor it is based on information made available through the courtesy of FAO.

THE Ministry of Agriculture in Finland comprises two sections: (1) a general section for agriculture, forestry, land settlement, fisheries and other allied branches, and (2) a Veterinary Section. Attached to the Ministry are a number of central and technical offices organised on a corporate basis—the Board of Agriculture, the Board of Forestry and the Land Settlement Board.

The Board of Agriculture has eight sections comprising:

(1) A general agricultural section, divided into several branches dealing with (*a*) Advisory work, (*b*) Agricultural statistics, (*c*) Agricultural economics, (*d*) Government subsidies, (*e*) Land clearing, (*f*) Laboratories, and (*g*) Management of state lands, mainly school farms.

(2) An educational section.

(3) A home economics section.

(4) A home industries section.

(5) A fisheries section.

(6) An animal husbandry section.

(7) An engineering section.

(8) An administration section.

The Board of Forestry has two sections, *i.e.* (1) a private forests section, responsible for the supervision of private forestry, and (2) a State forest section, with a more comprehensive sphere of activities in the administration and management of State forests.

While research and education are directed and administered by the State, advisory work is carried out to a great extent by organisations founded by the farmers themselves. The State gives them assistance in the form of annual grants.

The Finnish Central League of Agricultural Societies is the most important. It has 18 district agricultural societies with about 1,800 local clubs for men and 1,200 for women, members totalling about 246,000. They employ more than 1,000 advisory officers, of whom about 100 have had university training. About 500 are general agricultural advisers, 60 are engaged in animal husbandry, about 300 in home economics and horticulture, 20 in fisheries, 20 in farm buildings, 15 in bookkeeping, and 15 in home industry. In addition there are about 200 control assistants for the milk recording societies.

The small Farmers' League is a society of tenants. Besides advisory work on technical matters, its programme also includes policy and politics affecting the interest of small holders. It has about 40,000 members.

The small farmers' League of Finland has about 350 sections with a total of some 20,000 members.

There is also an association of Young Farmers' Clubs, founded in 1928. Farm-youth club work in Finland is similar to that of the 4-H clubs in the United States.

In addition there are some 15 specialised associations dealing with different aspects of agriculture. They are mostly members of the Central League of Agricultural Societies but work independently of one another. They are concerned with various kinds of livestock, swamp reclamation, grassland improvement, drainage, seed production and similar activities. They include:

(1) *The Finnish Cattle-Breeding Society*, amalgamated in 1948 with the East, West, and North Finland Cattle-Breeding Societies. Membership: 20,000. Personnel: 50.

(2) *The Ayrshire Cattle-Breeding Society*, comprising 14 district societies, was founded in 1901. Membership, 9,000. Personnel: 30. These breeding societies keep pedigree records, supply breeding stock, found and direct bull associations and, in co-operation with the general advisory service organisations, hold competitions and exhibitions to promote cattle-breeding and cattle husbandry.

(3) *The Central League of Horse-Breeding Societies*, comprised of 18 district societies and 470 local societies, was founded in 1908. Membership: 40,000. Personnel: 35. The 18 district societies coincide with those of the agricultural societies. They aim at improving breeding of the Finnish horse. They arrange shows, draft tests, and competitions for horses, assist in the provision of breeding animals, maintain stallion paddocks, organise courses in horse husbandry, arrange competitions in horse-breeding, found and direct local horse-breeding societies. The local societies maintain stud stallions, some of them also own stallion paddocks and organise competitions. The central league has founded a co-operative society for the export of Finnish horses. The work of the societies is carried on in co-operation with that done on behalf of the Government for the development of horse-breeding. Government activities comprise the keeping of the studbook, procuring of stallions for breeding purposes, assisting with grants and services of the Government officials, awarding prizes in the special State shows and competitions.

(4) *The Pig-Breeding Society* was founded in 1908. Membership : 4,000. Personnel: 16. This society aims at improving the domestic breed of pigs and further developing and spreading the imported Yorkshire breed. The society keeps a pedigree record.

Liaison between research and advisory services

The liaison between research and advisory services is not close. Each year the central advisory organisations arrange a meeting of their advisers, lasting several days, at which research workers and professors of the Faculty of Agriculture and Forestry deliver lectures. Local experiments are directed and summarised by an expert attached to the Central Board of Research, attached to the Ministry of Agriculture. For these local experiments the organisations lack the necessary equipment to work efficiently, *e.g.*, tractors, jeeps, threshing machines and supplementary implements.

The crop husbandry branches of the Central Research Institute comprise nine in all; ten State experiment stations located throughout the country work independently.

The Central Board of Research has two committees, one for crops and one for animal husbandry.

The nine branches of the central Research Institute comprise agricultural chemistry and physics, soil science, crop husbandry, crop breeding, phytopathology, entomology, horticulture, animal husbandry, and animal breeding.

The faculty of Agriculture and Forestry of the University of Helsinki also conducts research work in agricultural chemistry, microbiology, crop husbandry, dairying, agricultural policy, nutrition, and home economics. The faculty has three experiment farms. There are other state research institutions apart from the above; they include: The Dairy Experiment Station, a recently-opened Research Station for Agricultural Machinery, the Agricultural Economics Office, the Agricultural Statistics Office and the Engineering Section of the Board of Agriculture. In addition there are several state institutes such as the Agricultural Chemistry Laboratory for testing fertilisers and feedstuffs, and a Seed-Testing Station.

The Dairy Science Society, founded in 1937, promotes research in dairying and issues the Finnish *Journal of Dairy Science*.

Agricultural education: elementary

Professional teaching in agriculture is given in nearly 100 schools with about 200 full-time teachers, and about 3,000 pupils; 2,000 pupils get practical training at approved and supervised training centres.

At a majority of the schools only theoretical instruction is provided, while practical courses are given at about 1,000 selected training sites owned by private farmers and supervised by the teachers.

In addition there are seven itinerant agricultural schools providing elementary agricultural education in sparsely populated districts, with courses lasting from four to eight weeks.

There are nine schools of agriculture with two-year courses; the minimum age of admission is 17.

As to animal husbandry, there are 16 cattle-husbandry schools, with a theoretical course lasting five months and one year's practical training on an approved farm, and in addition eight Finnish language cattle-husbandry schools, with two-year courses, one pig-husbandry and one poultry-husbandry school, two horse-husbandry schools and three dairy primary schools. There are also four horticultural schools. There are about 50 schools of home economics, with about 2,500 pupils.

Secondary professional schools (colleges) are mainly used for the preparatory training of advisers. Before admittance to the agricultural colleges it is necessary to have passed one of the primary professional schools and to have had one year's practical training, or to have passed an ordinary secondary school with one and a half year's practical training. There is one animal husbandry college with about 30 pupils, a dairy college with about 30 pupils and two horticultural colleges.

Higher agricultural education

Higher education in agriculture and forestry is provided at Helsinki University, where a Faculty of Agriculture and Forestry was established in 1925.

The faculty has an estate in Malminkartano covering 180 hectares, one at Vik of 240 hectares, and a third in Lapland, o carry on experiments and demonstrations.

The agronomy course covers four and a half to five years, including one year's practical training at a farm approved by the faculty. Students may study four branches for three years; crop husbandry,

The extensive cultivated plains of Western Finland are well adapted for the use of modern agricultural machinery

animal husbandry, dairy and agricultural economics. The course also includes limited instruction in forestry.

The faculty has a training forest of approximately 17,000 hectares. Since 1944, students in forestry may choose several courses. Students of agriculture and forestry number about 1,500, of whom roughly one-third study forestry.

Advisory services

It is difficult to obtain accurate information on the percentage of farms and classes of farmers actually reached by the advisory service. The number of advisers seems to be adequate, averaging one general adviser —excluding the specialist advisers—for about 600 farms. The coverage of service, however, does not seem to be uniform. Among the scattered settlements the advisory service seems to be inadequate and in some districts there seems to be overlapping of activities by the different advisory organisations which work independently and may even compete with each other. In the last few years the advisory organisations were charged with supervision and advisory work relative to land settlement.

Training of advisory personnel

In the pre-service training of advisory officers at Helsinki University the agronomy course is divided along four or five lines. Only limited instruction is given in farm economics, agricultural machinery, grassland husbandry, drainage and farm building.

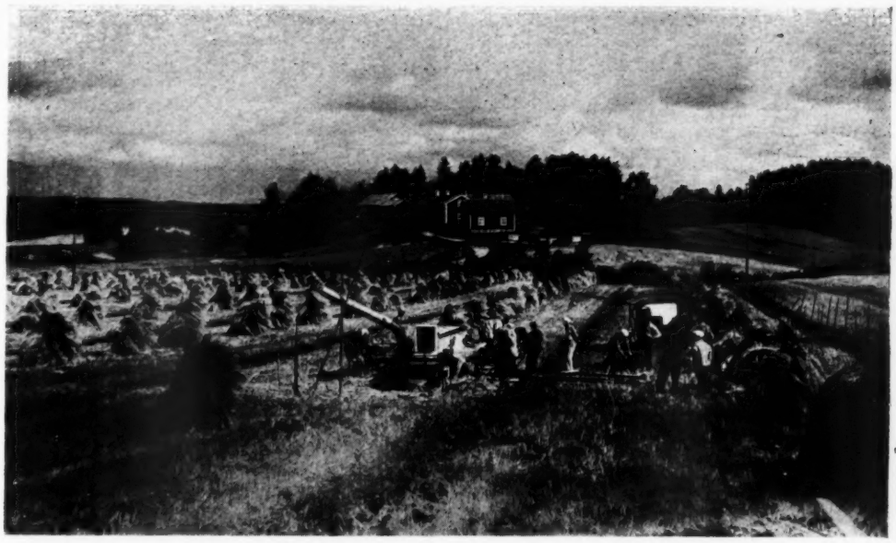
There is little organised training of advisory personnel at the time they are inducted into the service in advisory aids, planned building, farmer approach, public speaking and training in organisation methods. Only the college for small farmers' advisers provides some training in advisory methods.

Advisory methods

In spite of the fact that there are so many different organisations engaged in advisory work and so many types of advisers, advisory methods generally are the same.

Regulation and administrative work was assigned to the advisers to a great extent during the war and after, but since rationing has been abolished this work has diminished considerably. Distribution of State remunerations, loans and subsidies, however, is part of their work, as is the collection of agricultural statistics, land classification and verification for use in granting agricultural credits and supplies for land clearing.

Soil samples for analysis of soil fertility are taken on a small scale—approximately 40,000 a year—because of the lack of laboratory equipment. To promote the efficient use of fertilisers, however, it is planned to extend this activity, the immediate goal being 100,000 soil samples a year.



A machine like this combine harvester, the capacity of which exceeds the small farmer's own need, can be jointly purchased and used by several farmers

Foodstuffs are also sampled for analysis to a limited extent.

Other routine work, such as milk recording, is done extensively. About 25% of Finnish cows are recorded. Recorders visit the farms once a month and the farmer himself records twice a month. This routine work is linked with drafting proper feeding schemes and the assistants, on their visits, may advise on animal husbandry as a whole.

Visits to individual farms are made to a varying degree. Advisers furnish advice, guidance and draft plans of various kinds concerned with crop and animal husbandry, horticulture, farm buildings, fisheries and forestry.

Advice on subsoil drainage is provided by officials of the drainage organisation and the engineering section of the Board of Agriculture.

Compared with the growing interest in mechanisation, the number of advisers specialised in agricultural machinery is insufficient.

The advisory organisations arrange large group excursions, organise farm competitions and, to a small extent, demonstrations with agricultural machines. They arrange exhibitions in co-operation with various local, regional and national organisations.

Numerous lectures and courses are given by the advisers, lasting for some hours to some weeks. This emphasis on educational work is partly owing to the lack of professional teaching in Finland, where only about 15% of the farmers can graduate from an agricultural school.

Finance

State funds allotted to agriculture in 1950 amounted to approximately 6,500,000,000 markkas and for forestry to about 600,000,000 out of a total budget of 104,400,000,000 markkas. Thus about 6.2% of the total budget was allocated to agriculture. For the agricultural budget 308,000,000 markkas were made available to the advisory services, 333,000,000 for agricultural education, 85,000,000 for research, 1,100,000,000 in subsidies to farmers for land clearing, 2,600,000,000 to carry into effect the Land Procurement Act—mainly the resettlement of refugees—50,000,000 for regular settlement and 1,000,000,000 to support agricultural production, mainly by subsidising fertilisers for small farmers. Thus the advisory and education services each receive about 50% of the total budget of the Ministry of Agriculture.

Advisory work

The Government brings practically no influence to bear on the advisory programme. The section of the Board of Agriculture officially charged with supervising advisory work only controls the expenses for which the advisory organisations have to render an annual account. Once a year or once in two years the five general advisory organisations independently convene the representatives of district organisations to discuss agricultural policy and general measures to be taken.

Little is done in advising the public on the contribution of agriculture to the national economy, welfare and standard of

living. The Finnish Broadcasting Company, however, in 1949 reserved 45 hours a year for agriculture and forestry and 30 hours for home economics in the Finnish language and 15 and 10 hours for the same subjects in Swedish. In general, purely technical subjects were treated.

There is no central 'information service' to prepare information circulars and bulletins, arrange and prepare broadcasts, prepare advisory aids, and train advisers in the use of them. The leagues of the general and special organisations at headquarters independently issue leaflets, papers and booklets, prepare film strips and slides, and make maps from air photographs. As a result, although many of them complain about shortage of funds, more than 30 different agricultural technical periodicals are issued by the different organisations.

Summary and conclusion

Notwithstanding the limiting factors of climate and soil, Finnish agriculture has made extraordinary progress during the present century, especially since 1917, when Finland became independent. From 1920 to 1939 the cultivated area increased by one-third. The yield per hectare at the same time increased considerably; for cereals by about 30%, for potatoes nearly 100%, while production per cow increased almost 50%. Since the last war a remarkable recovery has been made. About 15,000 destroyed farm buildings in the north have been rebuilt. The majority of the rural displaced population from the ceded territory—comprising more than 10% of the total cultivated area—and more than 10% of the total population have been resettled on farms or homesteads, and land settlement for war-stricken people is proceeding rapidly. The co-operative movement, handling about 60% of the aggregate value of the domestic products marketed, and especially the Pellervo Society, has done a great deal of work in stimulating agricultural progress. In spite of the scarcity of funds, agricultural research has achieved valuable results. The same applies to the professional education level of rural people all over the country, where farms are at relatively wide distances from each other.

Particularly notable is the excellent work done among rural youth along the lines of the 4-H Club work in the United States of America; Finland is perhaps the most advanced country in Europe in this field.

The agricultural advisory services, working principally on a voluntary basis, through their numerous general and special organisations, have contributed largely to the development of agriculture and forestry.

Most impressive of all is the energy, industry and natural intelligence of the Finnish farming population. Half of the population is directly dependent on agriculture and farm forestry for their livelihood. Since the war 20% of the national income has been derived from agriculture and 70% of the annual cut of wood has come from farm woodlands.

The management of a modern farm requires wide knowledge in many different fields, and knowledge of both technical and economic matters is essential. The advisory services try to provide both kinds of knowledge. They must be based on adequate research and widespread professional teaching of the farming population. The function of the advisory service is to provide up-to-date information on the efficient utilisation of the total resources of farms. When this advice is put into practice by a growing number of farmers, it leads to a considerable increase in the total output of agricultural products at the lowest possible costs and it increases national income by benefiting both the rural and urban populations.

Finland has made outstanding progress in the organisation of advisory work, particularly in home economics and farm youth organisation, and her example could, with advantage, be studied by many other countries.

Houses for resettlement have gone up in Northern Finland

Photos : Finnish Legation, London

Agricultural and Horticultural Problems of Brazil

Concluded from page 344

demand for copper fungicides, principally cuprous oxide formulations, is bound to increase.

Mango

The mango industry in the north of Brazil is a relatively large one, although exact statistics on production are not readily available.

Mangoes in Pernambuco are heavily attacked by the fungus *Diplodia recifensis* (Recife Sickness), introduced by the beetle *Xyleborus affinis*. This insect carries the spores of *D. recifensis* into the tunnels which it bores through the trunk. The beetle does not eat wood, but lives entirely on the fungus which it propagates on the faces of its galleries. Due to reduced oxygen tension within the borings and continual cropping by *Xyleborus*, the fungus produces no pycnidia.

Diplodia recifensis usually kills the mango tree in two years or so and some 120,000 trees are estimated to die each year from this disease. Once *Diplodia* has gained entry to the cambium the tree is doomed. The only possible line of attack is against *Xyleborus* before it starts boring. Practically every chemical has been tried against this very resistant beetle except parathion, but the Institute de Pesquisas Agronomicas in Recife are now laying down extensive trials with the new organo-phosphorus compounds and it is hoped that a solution will be found in measurable time.

Conclusion

Excellent work is being done in the pest control sphere by a number of private companies and by members of the official agricultural institutes. Much more can, and will, be done in the future, but it is very necessary that better provision should exist for making known recent technical advances to the farmer, and particularly to the smallholder, whose education in the pest control field is, through little fault of his own, sometimes deplorable.

Photos : Plant Protection, Ltd.

Vineyard near the Lofty Ranges of South Australia. Well over half of Australia's wines are produced in this State

Research on South Australian Soils

J. A. PRESCOTT, C.B.E., D.Sc.

Director, Waite Agricultural Research Institute

The study of the soils of the Australian continent has made noteworthy progress during the past half-century, and some of the results have profoundly influenced farming practice in that country in addition to providing information of interest and importance on problems of soil management in other countries. In this work the Waite Agricultural Institute has played a leading part; the following article by its director, Dr. J. A. Prescott, summarises the main features of Australian soil research.

THE study of the fertility problems of South Australian soils may be said to have started with the foundation of Roseworthy College. The earliest permanent experiments at the College go back to 1904 and information was also then becoming available from the State of Victoria, where experiments on fertilisers were extensively conducted during the early years of the century.

The Waite Agricultural Research Institute and the Commonweath Scientific and Industrial Research Organisation have both since entered the field and all three have contributed a major share to successful scientific research into agricultural problems in South Australia.

Use of superphosphate

Although superphosphate was patented by Lawes in 1842 and its importance for English agriculture established by the Rothamsted Experiments, it was some 40 or 50 years before it came to be used in Australia. It was Professor Custance of Roseworthy College who conducted the first field experiments demonstrating the value of superphosphate as a fertiliser for wheat and it was his successor, Professor Lowrie, who succeeded in popularising its more general use in the State.

From about 1880 until 1910 the area under wheat in South Australia remained relatively constant at rather less than 2,000,000 acres. In 1897 only 3% of this area was treated with superphosphate, but five years later, in 1902, the proportion had increased to 44% and in 1907 to 69%. In 1912 the proportion reached a steady value of about 85% and the dressings used were of the order of 80 lb. per acre.

The next stage in the scientific investigation of the problem, that of ascertaining the most useful dressing, was mainly the work of Professor Perkins, who initiated a series of field experiments at Roseworthy and at special Government farms where various amounts of superphosphate up to 3 cwt. per acre were tested on wheat. From these experiments it became possible to assess the most profitable dressing, having in mind the price of wheat and the cost of the superphosphate. It was generally evident that quantities greater than 80 lb. per acre could be used with profit and in most cases 180 lb. or more.

One important feature was that not only were wheat yields increased but there was a substantial improvement in the grazing value of the stubbles and following self-sown pastures.

An event of some importance was the purchase about 1906 of the estate of Kybybolite for closer settlement. An area was set aside as an experimental farm and trails were conducted with crops and fertilisers. It soon became evident, however, that the locality was not suitable for cropping in wheat, and by 1920 a policy of transition from cropping to grazing had been adopted. Kybybolite is near the Victorian border in what is known as the middle south-east of the State and the experience gained there with pastures laid the pattern of much subsequent work in South Australia.

At this period also the first attempts were made to solve the problems of the ironstone soils of the Hundred of Seddon on Kangaroo Island. About 1908 Dr. Richardson set up a series of fertiliser trials on the island, but again attention was paid to cropping with barley, oats and wheat rather than to the needs of pastures.

The key to the pasture problem came with the discovery of the importance of subterranean clover as a pasture legume and

the advocacy of its use by A. W. Howard, a farmer in the Mount Barker district. Subterranean clover had been known for many years; indeed, there is an early record of its identification by the famous botanist, Von Mueller, for the Mount Pleasant branch of the Agricultural Bureau. Its importance was not recognised, however, until the top-dressing of pastures with superphosphate was tried.

Pasture problems

The earliest experiments with pastures at Kybybolite arose in part from a suggestion by the Department of Mines that the value of local rock phosphates as fertilisers should be assessed. In 1919 experiments were tried with Wimmera, rye grass and subterranean clover on native pasture and on pastures seeded on land previously cropped. It was natural that the standards for comparison should be the unmanured ground and that treated with superphosphate. These experiments were very fully reported upon in 1939 by Cook, who had been associated with them since their inception. From 1929 the experiments at Kybybolite were extended by co-operation with the Waite Agricultural Research Institute and the Commonwealth Scientific and Industrial Research Organisation with financial assistance from the Empire Marketing Board.

The most striking features of these experiments may be summarised in terms of carrying capacity in sheep.

This striking increase in carrying capacity is due to the overall response of the pasture plants to phosphate together with the extraordinary response of the clovers and illustrates the general situation in South Australia where a straightforward response to superphosphate is to be expected. It is of interest that more recent investigations at Kybybolite carried out on behalf of C.S.I.R.O. have shown no benefit to the sheep on these pastures from supplementary feeding with cobalt and copper.

The Waite Agricultural Research Institute was established by the University of Adelaide in 1924 and the earliest experiments at the Institute speedily confirmed the importance of phosphates both on cereal crops and on pastures. A simple trial with natural pasture was established in 1925 and is still being conducted. The total yields of herbage and the average carrying capacities for the 20 years 1928-47 are summarised on the right.

The difference between the natural carrying capacities at the Waite Institute and Kybybolite is associated with the phosphate* content of the natural soil. At the Waite Institute it is 0.040% and at Kybybolite 0.008%.

*Expressed as P_2O_5.

Residual effects

The most recent investigations on soil phosphates at the Waite Institute have had for their purpose the assessment of the benefit of the residues left in the soil after many years of treatment with superphosphate. There is reason to believe that when an aggregate amount of one ton has been used over the years, substantial useful residues are available and that responses to normal dressings of superphosphate are likely to be small.

The natural phosphate content of South Australian soils covers a wide range. It is probably associated with the number of cycles of weathering undergone by the parent material from which the soils have been derived. Thus the richest soil of all, the volcanic ash of Mount Gambier, may contain 0.30% of phosphate*; some of the black soils derived from the pre-Cambrian limestones, 0.17%; the red-brown earths of the wheat belt have a most frequent range between 0.04% and 0.06%, and the mallee soils from 0.01% to 0.03%. The podsols contain mostly less than 0.02%. A special group of soils such as the reclaimed swamps of the Lower Murray are relatively rich in phosphate, containing between 0.1% and 0.2%, and these soils, when drained, irrigated the year round and sown with appropriate pasture species, have extraordinarily high carrying capacities, up to 20 sheep to the acre, as was shown by Dr. Richardson.

Nitrogen supplies

The problem of the phosphate status of South Australian soils having been solved, the next problem was that of nitrogen supplies. The wheat bare fallow rotation which was characteristic of the early farming is really based on a gradual depletion of the original nitrogen reserves in the soil. These are reasonably high when the original phosphate is high, but after some 20 years of such exploitation declining wheat yields manifest themselves together with an increasing liability to soil erosion. The importance of nitrogenous fertilisers on stubble-sown crops was established in a series of experiments conducted by the Waite Institute from 1928 onwards.

The soils which in their native state are very low in phosphate, however, are also very low in nitrogen and reserves of the latter cannot be said to exist. The building up of the nitrogen level is to be regarded as a major objective in these cases of depleted and natural soils.

The value of medics, clovers and peas for this purpose is one of the most important facts that has been established by practical experience and experimental work. It is now well known that these leguminous plants function in this way, by their association with nitrogen-fixing bacteria, known as *Rhizobium*, which flourish in the nodules on their roots. Where land is sown for the first time with these legumes it is desirable to inoculate the seed with the appropriate strain of bacteria and some thousands of cultures are sent out each year from the Waite Institute. The Division of Soils of the C.S.I.R.O. has carried out a great deal of helpful work in this connection by investigating the factors responsible for the efficiencies of the various strains of bacteria that are available for this purpose. The most important legumes available for South Australian conditions are lucerne and the related annual medics for the lower rainfall regions and alkaline soils, peas for the main wheat belt, subterranean clover in a range of strains for the more reliable rainfall areas, and white and strawberry clover for the regions with longer and wetter agricultural seasons.

Micro-elements

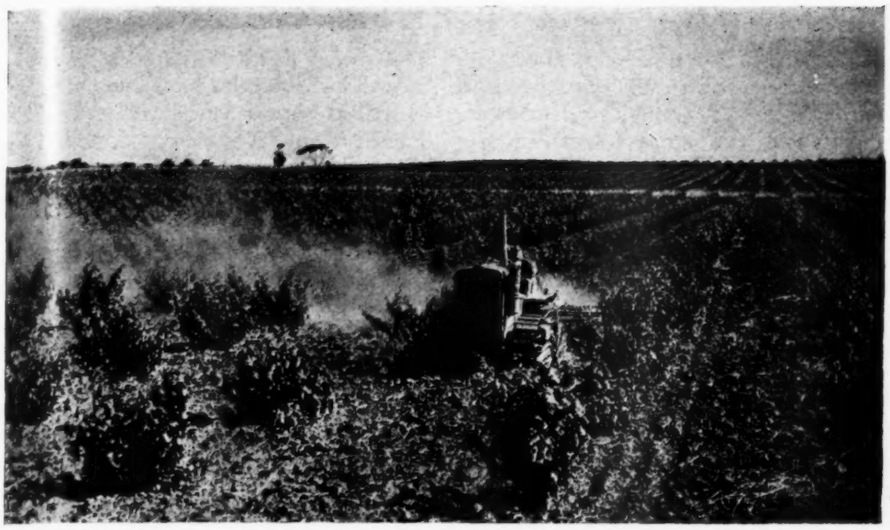
When the Waite Institute was established in 1924, the only two micro-elements whose need by plants was reasonably certain were boron and zinc, but no known cases of their possible value as fertiliser had as yet been observed in any part of the world. Salts of copper and manganese were, however, being used empirically by certain farmers in northern Europe. The first problem to be tackled in South Australia was that of a disease of oats at Mount Gambier, locally known as 'road take-all,' and referred to the Institute by Perkins, then Director of Agriculture. The soil on which the disease occurred was the richest in South Australia, at least with respect to phosphate,

EFFECT OF TOP-DRESSING WITH PHOSPHATES ON THE CARRYING CAPACITY FOR SHEEP AT KYBYBOLITE

	Sheep per acre		
	Natural pastures	*Wimmera rye gress and sub-terranean clover*	*Phalaris tuberosa and sub-terranean clover*
No manure ..	1.0	1.2	—
Rock phosphate ..	2.4	3.1	—
Superphosphate ..	3.4	4.4	4.2
Lime and super-phosphate ..	3.5	5.2	—

EFFECT OF TOP-DRESSING WITH PHOSPHATES ON NATURAL PASTURE AT THE WAITE INSTITUTE, 1928-47

	Total yield of dry herbage, cwt. per acre	*Sheep carrying capacity, sheep per acre*
Unmanured ..	36.3	3.0
Superphosphate ..	48.1	4.3
Rock phosphate ..	48.5	4.2
Basic slag ..	53.1	4.5



Discing the soil in a vineyard in Barossa Valley, 40 miles north of Adelaide in South Australia

and the work of Samuel and Piper led to its identification as grey-speck disease and its cause as being due to manganese deficiency. That manganese is indeed an element essential to plant growth was confirmed at the Institute by means of very carefully conducted solution cultures. Although boron-deficiency diseases were becoming known in other parts of the world, a survey based on the composition of apples grown in the State did not suggest any likely deficiency here and, in fact, subsequent experience, following a lead from Victoria, has shown that boron poisoning is quite likely to be associated with the salt problems of the irrigated areas. Later, solution culture experiments confirmed the essential character for plant growth of copper and zinc and the probable need for molybdenum.

Copper and cobalt

The next discovery of importance in South Australia was the results of the need to study crop and pasture establishment on areas known to be ' coasty ' for sheep. The work of the Nutrition Division of the C.S.I.R.O. had shown that ' coastiness ' was due to a double deficiency of copper and cobalt and it was natural that on the highly calcareous soils which were then being studied the value of copper as fertiliser should be recognised. These experiments began in 1936 as a joint effort of the C.S.I.R.O. and Waite Institute and the identity of some of the symptoms observed with those of ' reclamation ' disease in Europe confirmed the need for copper.

Zinc

The recognition of the need for zinc came later. It had been known since 1870 from work in France that zinc was an element of likely biological importance. The news of the first practical application of this came from California in 1933 and was followed in 1936 by the discovery of its importance as a fertiliser spray for pine trees in Western Australia.

The hint that zinc might prove to be of importance nearer home came from the application of the Californian experience in the irrigated orchards of the River Murray and from the experience of the Victorian Department of Agriculture with wheat at Nhill in 1936.

This Victorian experience led to the trial by farmers of zinc salts on the wheat lands of the adjacent South Australian district of Tatiara, and in 1941 the State championship went to the grower of a wheat crop in this district who had used a dressing of 10 lb. of zinc sulphate to the acre in addition to superphosphate.

Further west still, near the coast at Rendelsham and Woods Well, suggestions of the likely importance of zinc for subterranean clover were obtained in 1942 by workers from the Waite Institute. Zinc was also found to be important to the growth of flax. With the development during the war years of the growing of flax as an economic crop in South Australia, failures were encountered on certain soils in the lower north of the State. These soils were usually dark in colour and of heavy texture and had some affinities with the soil at Nhill. Investigations were begun in 1941 and it was shown that the symptoms of the unthrifty flax were the same as those seen in flax grown in solution cultures in the absence of zinc. In field experiments, very clear responses to dressings of compounds of zinc were demonstrated in the early growth of flax on these soils.

The importance of zinc together with copper as a supplement to the standard phosphate dressing for pioneering on the so-called Ninety-mile Plain, was established by experiments conducted by Riceman of the Division of Nutrition of the C.S.I.R.O. at Keith in 1944 and these experiments have paved the way to the possibilities of the efficient use of subterranean clover and possibly other legumes for building up the fertility of this very extensive area.

Molybdenum

One other micro-element has proved to be of exceptional interest in connection with the building of soil fertility in South Australia and that has been molybdenum. Whereas of the soil improvers, lime and gypsum are required in tons per acre, compounds of phosphate and nitrogen in hundredweights and those of zinc, copper, boron and manganese in pounds, molybdenum is required in ounces per acre. The hint that it might be of importance biologically came from the work of a German bacteriologist in 1931. In South Australia, certain ironstone soils in the Adelaide Hills had shown a consistent lack of response over the years to dressings of superphosphate; such clover as grew remained stunted but responded remarkably to the application of wood ashes in addition to superphosphate. The first hint that molybdenum might be important came from an experiment conducted at Meadows in 1941 by Anderson, a C.S.I.R.O. scientist working at the Waite Institute. Subsequent work has confirmed this and it is very probable that the effect of molybdenum is the indirect one of stimulating nitrogen fixation by the nodule bacteria associated with the clover.

These micro-elements do not need to be used regularly and one dressing may be of service for three or four years. They should be used with circumspection as both copper and molybdenum are known to cause disorders in livestock.

So far as can be ascertained, the list is complete at present, but there are still certain puzzling features associated with the behaviour of the poorer soils of the south-east and Kangaroo Island. Scientific research into the problems of soil fertility in South Australia still offers plenty of opportunity for obtaining new knowledge, and there is still much need for the study of the economic requirements of the various plant species and soils that are available for development.

(From ' Building Soil Fertility in South Australia,' issued by the Commonwealth Bank of Australia, July 1950.)

Photos : Australian News and Information Bureau

British Association

The 113th annual meeting of the British Association was held in Edinburgh from August 8 to August 15, 1951. This year, being Festival year, the meeting, which is always an event in the scientific year, was particularly significant. The President of the Association on this occasion was His Royal Highness the Duke of Edinburgh, who, in his Presidential address, reviewed the British contribution to science during the last 100 years.

The agricultural section met from August 9 to August 14, under the Presidency of Dr. E. M. Crowther, who, in his address, reviewed progress in regard to working methods in experimental agriculture.

The subsequent meetings of the agricultural section were directed respectively to surveys of fertiliser practice, trends and future prospects of fertiliser usage, the storage of farm products, agricultural problems of marginal land farming, limits to intensive production in animals and (conjointly with the geographical section E) surveys of development areas.

Among those contributing papers under these various heads were Dr. F. Yates, Prof. S. J. Watson, Sir Patrick Laird, Prof. W. Elison, Prof. R. A. Shephard, Dr. John Hammond, Dr. A. S. Thomas, Sir Geoffrey Evans and Dr. Herbert Green.

We hope to include an account of the proceedings of these sections in a subsequent issue.

400 Products Approved

Nearly 400 products have now been officially approved under the Crop Protection Products Approval Scheme. A committee of English and Scottish scientists acting in consultation with the Agricultural Research Council has now considered most of the important groups of insecticides and fungicides since it was set up in 1942.

Cocoa in Malaya

We regret that in Mr. G. W. S. Hartley's article on Cocoa Investigations in Malaya which appeared in our issue for August 1951 the photograph on page 290 was wrongly captioned. The photograph in question should have been entitled 'Cocoa plants crated for dispatch to planting sites in Malaya from the *Singapore Quarantine Station*' and not as stated 'from West Africa.' As stated in the letterpress the material imported from West Africa consisted of seeds only, on account of the risk of importing virus diseases. Plants from these are raised in the isolation nursery and thence dispatched to planting sites in Malaya.

The French Vegetable Oil Shortage

The French Government is faced with a very serious edible oil deficit which, a few years ago, it had planned to avoid, reports our Paris correspondent. In 1947 the price of colza seed was fixed by law at the same level as that of wheat and, for this reason, the price of oil has since risen steadily. Nevertheless, despite this encouragement, production has lagged. It was estimated that by 1952 domestic colza production would amount to 103,000 tons which, with 7,000 tons of olive oil, would bring the total to 110,000 tons. This year, however, production is expected to reach no more than 65,000 tons, or about 70,000 including olive oil.

This is a long way from French consumption demands, which are estimated at 255,000 tons, and even this is 20% below pre-war. As the French Union will only be able to supply 95,000 tons against an estimated 113,000 tons the year's deficit will amount to about 90,000 tons.

It is estimated that after the effects of the rearmament programme have worn off and the standard of living rises, France will need about 325,000 tons of oil per year. This means that an effort must be made now to increase colza production at home as well as olive production abroad. The French Union, it is estimated, should be able to produce at least 161,000 tons per year, including olive oils, but this will still leave a deficit of 164,000 tons.

The special committee set up by the Ministry of Agriculture to study the question has therefore proposed that steps should be taken at once to meet this deficit by increasing the domestic production of colza. The aim, the committee maintains, should be about 150,000 tons. This would demand that about 300,000 hectares should be given over to colza.

The committee considers that its intensive cultivation, particularly in those regions where beet is grown, should not interfere with other agricultural production, but also points out that there is continued resistance on the part of farmers despite the Government's effort to meet their price demands. There is little doubt that the Government will make another effort by increasing the guaranteed price, but as prices increase there may be a gradual reduction in consumption.

The Effect of Surface Cultivation on Soil Structure and Crop Growth

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WORLD CROP REPORTS

WORLD

Cacao production revised. World cacao production in 1950-51 now is estimated at about 1,699 million lb., slightly higher than an early season forecast of 1,687 million lb., but still a little lower than the record output of 1,711 million lb. in 1949-50. Despite rather sharp variations in output in individual countries, world cacao production has been remarkably level in recent years. In general, bad weather and poor crops in some countries have been offset by good weather and large crops in other countries. Remunerative cacao prices have encouraged new plantings, better care of bearing cacao trees and closer harvesting.

Africa produces about two-thirds of the world supply of cacao beans. Production in 1950-51 now is estimated at 1,141 million lb., compared with 1,091 million in 1949-50 and 1,151 million in 1948-49. South America accounts for about a quarter of world cacao production and North America one-twelfth. Cacao production in Asia and Oceania is relatively insignificant. Production in South America in 1950-51 is estimated at 412 million lb., compared with 461 million in 1949-50 and 381 million in 1948-49. North America's cacao output in 1950-51 is estimated at 133 million lb., compared with 146 million in 1949-50 and 125 million in 1948-49.

The Gold Coast and Nigeria alone produce about half of all the cacao beans in the world. Although seriously menaced by widespread Swollen Shoot disease, production remains high. The forecast of 625 million lb. for the 1950-51 crop in the Gold Coast has been revised downward to 600 million lb., but Nigeria's 1950-51 crop will probably total 246 million lb. instead of 235 million as forecast earlier. Production in 1950-51 now is forecast at 120 million lb. for French West Africa and 105 million for French Cameroons and Equatorial Africa.

Next to the Gold Coast, Brazil is the leading source of cacao beans. If cacao prices remain high, it is likely that the Brazilian cacao industry will expand considerably during the next decade. Production in Brazil reached a peak of 357 million lb. in 1949-50, but suffered a temporary setback in 1950-51 as a result of unfavourable weather. The 1950-51 crop currently is estimated at 294 million lb. Production in 1950-51 now is forecast at 60 million lb. for the Dominican Republic and 51 million for Ecuador.

SOUTH AFRICA

Drop in sugar estimates. In consequence of the drought conditions experienced last year and which continued well into the current year, states *C. Czarnikow*, Ltd., estimates of the 1951-52 crop as at June 1 have had to be revised to 625,000 short tons (558,000 long tons) which compares with the first estimate of 645,000 short (576,000 long) tons, and a production last season of the record figure of 612,000 long tons. In view of this reduction of some 54,000 long tons, the prospect of any sugar being available for the United Kingdom disappears entirely, whilst doubts are entertained that there will be sufficient sugar to meet the full requirements of the home market.

CHINA

Raw cotton shortage closes mills. The Chinese Communists are reported to have closed all cotton mills in China for a month and a half starting June 6, because of a shortage of raw cotton. Although the 1950 cotton crop was reported to be about 2,500,000 bales, compared with the small 1949 crop of 1,700,000 bales, the supply is still insufficient to meet the demands of the cotton mills and the large cottage industry. A contributing factor to this temporary suspension of mill operations is the decreased imports of raw cotton into China during recent months resulting indirectly from Chinese intervention in Korea.

AUSTRIA

Optimistic potato forecast. The improvement in the condition of the Austrian potato crop has been so great owing to better weather in the main crop districts that agricultural circles predict a record harvest. This would assure the carry-over until the 1952 harvest and guarantee supplies to industry.

Austria will probably be able to dispense with imports of potatoes until next season, which would mean a return to pre-war conditions.

BRAZIL

Bumper wheat crop. Brazil will this year have the largest wheat crop in its history, according to her Minister of Agriculture. Prospects are that crops in the Rio Grande do Sul will be 30% and in Parana 20% larger than last year.

Special warehouses are being built to handle the crop.

Cotton production 1940-50. Below is a table showing the production and export of cotton during the last decade, as printed in the Brazilian *Bulletin*. It is reported that current year (1950-51) prospects are encouraging and a bumper crop is expected.

World consumption of cotton for 1950-51 is estimated at about 5,000,000 bales more than the calculated production, so Brazil's exportable surplus will present no disposal difficulties.

COTTON PRODUCTION AND EXPORTS IN BRAZIL.

Crop	*Production (Tons)*	*Exports (Tons)*
1940–41 ..	469,000	224,265
1941–42 ..	503,000	288,274
1942–43 ..	377,000	153,954
1943–44 ..	496,000	77,962
1944–45 ..	592,381	107,640
1945–46 ..	378,495	164,456
1946–47 ..	377,767	352,752
1947–48 ..	346,525	285,473
1948–49 ..	317,338	258,703
1949–50 ..	395,969	139,759

Economic developments, 1950. Thanks to coffee and the international situation, business boomed in Brazil last year, reports the *Bulletin* of the Brazilian Government Trade Bureau in London. Coffee brought the highest prices ever recorded during the second half of the year and provided two-thirds of the total exports. Actual production of coffee was about the same as in 1949.

Other reports show that the **cocoa** crop was very disappointing; estimated at 156,700 tons, it turned out to be only 128,600 tons. The **rice** crop increased 18% in volume, but exports were negligible owing to the low world market price. **Wheat** production increased by 187% over 1949 to a total for the year of 514,000 tons. So far wheat can only be grown economically in the State of Rio Grande do Sul. The **cotton** crop was good, despite dire predictions to the contrary, and increased 11% in volume over 1949.

NEWFOUNDLAND

Pulp and paper output. The entry of Newfoundland into the Canadian Confederation added appreciably to the forest area of Canada of over 1,200,000 square miles. It is estimated that about 17,000 square miles of the island of Newfoundland are covered with forest; no estimate is available of the timber resources of Labrador.

Exports of pulp and paper accounted for about half of Newfoundland's total export income before the war, with the United Kingdom as the principal market. During the war the market in the United States was expanded, while new markets were opened in South America and in Australia. Most of the output now goes to the United

States and there are long-term contracts for future output.

Pulp and paper are the most important forest products. Most of the available timber resources (about 11,000 square miles) are held by two companies, with United Kingdom capital, which operate large mills—one at Corner Brook on the west coast, and one at Grand Falls, near the east coast. In the remainder of the forest area small concerns operate more than 800 sawmills, chiefly for local requirements. The industry employs about 10,000 people; its competitive position is good because of its proximity to water transportation.

In 1948 the following quantities of forest products were exported:

	Tons
Newsprint	342,597
Wood pulp (unbleached sulphite)	42,885
Wood pulp (mechanical) ..	778
	Cords
Pit props	14,171
Pulpwood	81,922

BRITISH EAST AFRICA

Cotton production. The 1950-51 production of cotton in the British East African colonies of Uganda, Kenya and Tanganyika is estimated at 328,000 bales (500 lb. gross weight), or slightly below the 333,000 bales produced in 1949-50, according to a report in *Foreign Crops and Markets*.

Production in Uganda decreased 13,000 bales to about 270,000 bales in 1950-51, but this decline was partially offset by a 14% increase in production in Kenya from about 7,000 bales in 1949-50 to 10,000 bales during the current season and the 48,000 bales produced in Tanganyika, which was about 12% above the 1949-50 crop of 43,000 bales. The decline in Uganda production was caused by late plantings, unfavourable weather conditions and a shortage of migratory labourers usually obtained from the Belgian Congo during the cotton season. Increased output in Kenya and Tanganyika is attributable in some degree to increased acreage, but more to improved yields resulting from favourable climatic conditions and lack of insect infestation.

Local consumption of cotton in British East Africa is practically nil, being confined mainly to upholstering and blanket manufacturing. Plans have been made for the construction of a textile mill in Uganda, using electric power to be supplied from the Owen Falls hydroelectric project scheduled for completion in 1954. Production of this mill is expected ultimately to reach 27,000,000 yd. of cloth annually.

Marketing of the Uganda cotton crop, along with the crops from the interior provinces of Kenya and Tanganyika around Lake Victoria, is handled through the Uganda Lint Marketing Board, a Government-sponsored organisation established in October 1949 and consisting of representatives from all branches of the cotton industry. Under the present system, the Board purchases all cotton from the native growers at a fixed price, pays a fixed commission to the ginner, and then markets the lint cotton in accordance with prior arrangements. Under the bulk marketing agreement for the 1949-50 season, the entire production was sold jointly to the United Kingdom Raw Cotton Commission and the Government of India, with exception of about 6,000 bales reserved for sale to other British Commonwealth countries. About 65%, or more than 200,000 bales, was shipped to India under this agreement.

In October 1950 the Board announced the marketing arrangement for the 1950-51 crop, which specified joint sale to the United Kingdom Raw Cotton Commission and the Government of India of 200,000 bales, or two-thirds of the crop, which ever was larger. The remainder of the crop will be auctioned. This announcement was favourably received by the local cotton community, which had protested against the bulk sale of the entire 1949-50 production. From the size of the 1950-51 crop it appears that, under the formula established for the current season, slightly more than 200,000 bales will be exported to the United Kingdom and India, with the remaining 100,000 bales to be sold at auction.

East African cotton grown along the eastern coasts of Kenya and Tanganyika is not marketed through the Board, due to transportation difficulties, but is handled through separate exporting groups appointed by the Departments of Agriculture. The cotton marketed through these outlets, however, does not amount to much more than 8,000 bales.

WORLD CROPS

OUR NEXT ISSUE will include articles on two important industries—the **Natal sugar industry** and the **Australian wine industry**; the former has been written by Arthur C. Barnes, Director of Research for the Sugar Manufacturers' Association of Jamaica. Dr. R. O. Whyte writes on the **assessment of fodder resources** and there will be an article on **potato silage. The use of oil fractions as selective or total weedkillers** is the subject of a further article. The toxaphene story which was to have appeared this month, will be included in a later issue. The October number will carry other articles besides those mentioned above; also regular features and reports.

SWEDEN

Fats and oils production up. Sweden's production of fats and oils of vegetable and animal origin amounted to nearly 130,000 short tons in 1950, exceeding the previous year's total of 105,700 tons by over 20%, according to a report in *Foreign Crops and Markets*. Edible vegetable oil output, particularly from rapeseed, was reported at 81,000 tons. Linseed oil production was 15,400 tons.

The area planted to rapeseed was 312,600 acres, yielding 195,620 tons. Mustard seed output was 6,680 tons from 16,550 acres, yielding 1,800 tons of oil. 88,000 acres of linseed were planted.

U.S.A.

1951 crop estimates. The Crop Reporting Board of the United States Department of Agriculture makes the following estimates from reports and data furnished by its crop correspondents and agents which we reproduce in the table below:

1951 GRAIN CROP ESTIMATES FOR THE U.S.A., WITH COMPARISONS

	Production (million bushels)			*Harvested Acreage (thousand acres)*		
	July 1, 1951	*Final*, 1950	*Average*, 1939-48	*July* 1, 1951 (*acreage for harvest*)	*Final*, 1950	*Average*, 1939-48
All wheat	1,070.1	1,026.8	1,031.3	62,600	61,741	60,236
Winter wheat ..	706.7	750.7	758.8	40,900	43,816	42,895
All spring wheat ..	363.4	276.1	272.5	21,700	17,925	17,340
Durum	40.9	36.1	36.8	—	2,729	2,535
Other spring ..	322.5	240.0	235.7	—	15,196	14,805
Maize	3,295.1	3,131.0	2,900.9	84,600	83,302	88,007
Oats	1,368.0	1,465.1	1,274.5	37,900	42,027	38,762
Barley	262.6	301.0	310.7	9,800	11,191	12,858
Rye	25.6	23.0	32.2	1,800	1,822	2,674
Linseed	38.0	39.3	34.8	3,700	3,893	3,643
Soya beans for beans	—	287.0	164.5	13,100	13,291	8,764